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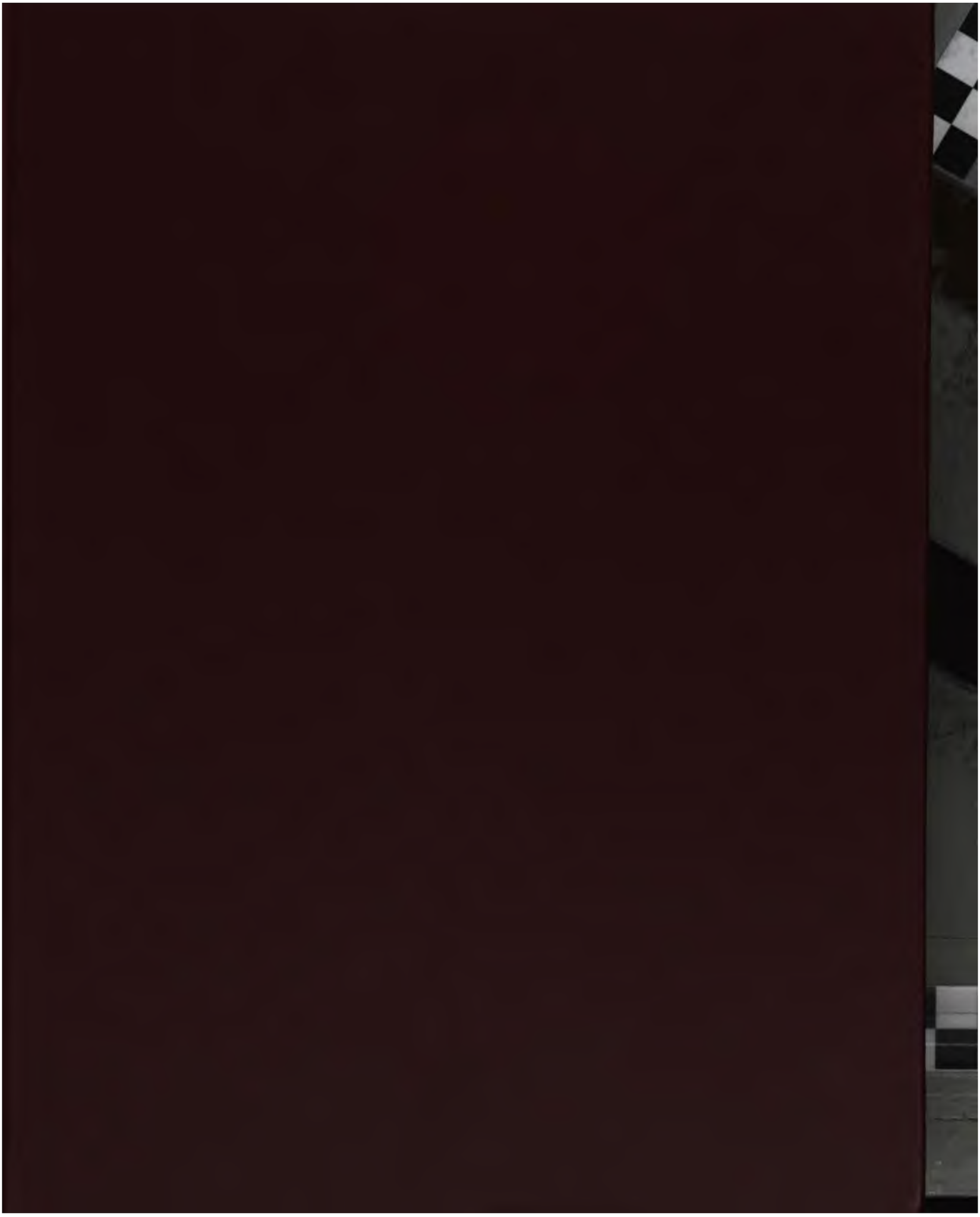

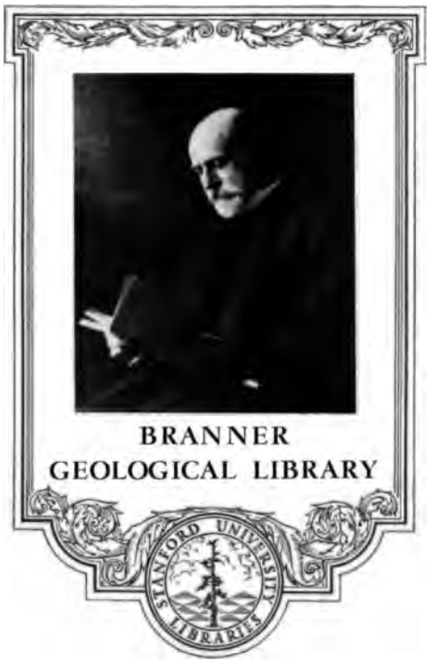
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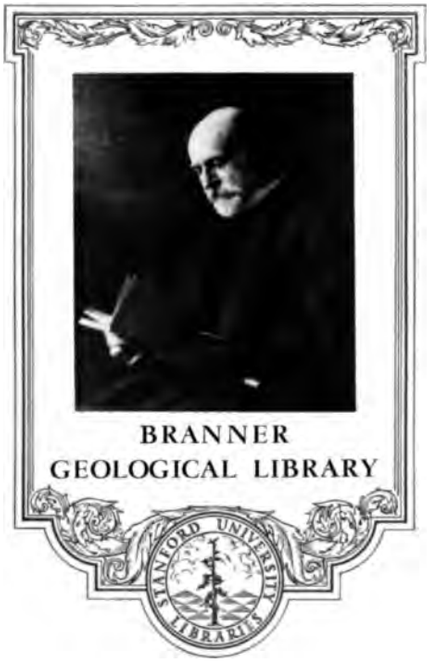
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Natural History

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Geological Survey of New-York.

PALÆONTOLOGY:

VOLUME III.

CONTAINING DESCRIPTIONS AND FIGURES OF THE ORGANIC REMAINS OF THE LOWER HELDERBERG GROUP AND THE ORISKANY SANDSTONE.

1855-1859.

BY JAMES HALL.

PART I : TEXT.

ALBANY:
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TO HIS EXCELLENCY EDWIN D. MORGAN,

Governor of the State of New-York.

SIR,

I HAVE the honor to submit to your Excellency that part of my Report upon the Palæontology of New-York, containing descriptions of the fossils of the Lower Helderberg group and Oriskany sandstone. All the species described in this volume have been illustrated by figures, drawn and engraved from original specimens, which have been collected under my own direction or derived from authentic sources since the year 1843. This volume of descriptions has been for some time completed and printed, with the exception of a hiatus from page 376 to 400, which, until the present time, I have been unable to fill in a satisfactory manner for the want of a sufficient collection of specimens.

The long interval which has elapsed since the publication of Volume II will be explained, when it is known that the work, by act of the Legislature and the authority of the Commission having charge of the same, was suspended from 1850 to 1855, and was only revived in the latter year.

I have the honor to be,

With great respect,

Your obedient servant,

JAMES HALL.

ALBANY, September 1859.

CONTENTS OF VOLUME III.

	Pages.
Preface, ...	
Introduction, ...	1 – 96
Rocks of the Helderberg mountains, ...	97 – 98
Crinoidea and Cystideæ of the Lower Helderberg limestones and Oriskany sandstone, ...	99 – 152
Brachiopoda of the Lower Helderberg group, ...	153 – 262
Lamellibranchiata of the Lower Helderberg group, ...	263 – 291
Gasteropoda of the Lower Helderberg group, ...	292 – 341
Cephalopoda of the Lower Helderberg group, ...	342 – 348
Articulata of the Lower Helderberg group, ...	349
Crustacea of the Lower Helderberg group, ...	350 – 381
Crustacea of the Waterlime group, ...	382 – 422*
Oriskany sandstone, ...	401 – 405
Crinoidea of the Oriskany sandstone, with reference to p. 138, etc.,	406
Brachiopoda of the Oriskany sandstone, ...	406 – 464
Lamellibranchiata of the Oriskany sandstone, ...	465 – 467
Gasteropoda of the Oriskany sandstone, ...	468 – 479
Pteropoda of the Oriskany sandstone, ...	479 – 480
Cephalopoda of the Oriskany sandstone, ...	480
New Species and Genera of Brachiopoda, ...	481 – 490
Catalogue of Species, and number of each from the Lower Helderberg group in Albany county, ...	492 – 493
Notes upon the Genus Graptolithus, and Description of species of this and allied genera, ...	495 – 522
Triplesia, Ambonychia, etc.	522 – 524
Trilobites of the Shales of the Hudson-river group, ...	525 – 529
Index, ...	530 – 532
Errata, ...	533

PREFACE.

THIS volume contains the descriptions and figures of all the fossils, exclusive of corals and bryozoa, at this time known to me as occurring in the Lower Helderberg group and the Oriskany sandstone, together with the peculiar crustacean forms of the Waterlime group, which lies at the base of the Lower Helderberg rocks, and marks a very distinct geological horizon over several hundred miles from east to west, while it is also recognized in a southwesterly direction as far as Virginia.

The number of species described, belonging to these rocks, is 345; and should the number of zoophytes equal those of the Niagara and Clinton groups, the fauna of the Lower Helderberg group and Oriskany sandstone will yield above four hundred species within a range of a few hundred miles.

With a view to the preparation of this work, collections were commenced in the rocks of the Helderberg mountains near Albany, in 1843, and continued with slight interruptions to 1857 : the results of these, in one small area, are given on pages 592 – 594. The collections from other localities have been less persistent, but the results of all are embraced in this volume.

The collection of fossils from these rocks, purchased of Mr. GEBHARD for the State Cabinet, has furnished the greater part of the Trilobites described, many of the Lamellibranchiata, and some of the Gasteropoda and Brachiopoda : the finer specimens of *Lepadocrinus* are likewise from this collection. I am indebted to LEDYARD LINCKLAEN, Esq., for the use of the very beautiful specimen of *Mariacrinus nobilissimus* figured on Plate II; and also to Col. E. JEWETT for the use of a similar specimen.

Plate II A, and for some other Crinoids and specimens of *Eurypterus*. To O. OSBORN, Esq., and to Mr. TOWER of Waterville, I am indebted for good specimens of *Eurypterus remipes* and fragments of *Pterygotus*. CARLOS COBB, Esq., of Buffalo, has allowed me the free use of his very fine cabinet of the Waterlime crustaceans, and nearly all those cited from Williamsville and the vicinity of Buffalo are from his collection; while the collections of the State Cabinet have furnished the beautiful new species *E. dekayi*, and the principal specimens for illustrating the *E. pachycheirus*.

I am more especially indebted to Mr. WILLIAM ANDREWS of Cumberland (Maryland), for the very liberal manner in which he has placed at my disposal his extensive collections, particularly of the Brachiopoda of the Upper Helderberg group and Oriskany sandstone, which, coming in at a later period than the study of these forms from New-York*, have enabled me to illustrate very satisfactorily the interior structure of *Rensselæria*, *Eatonia*, *Leptocœlia* and *Camarium*, and to give more complete illustrations of many other species which are shown upon the later plates. From the Gasteropoda furnished me by this gentleman, I have obtained very satisfactory illustrations of the Genus STROPHOSTYLUS, and much instructive material for the study of the Genera PLATYOSTOMA and PLATYCERAS; the specimens being free from adhering stone, and showing extreme modifications of the form of the aperture and the incipient development of the columellar callosity. All the specimens illustrating the Crinoidea of the Oriskany sandstone have been derived from the collection of Mr. ANDREWS.

Prof. SAFFORD of Tennessee has placed in my hands some interesting specimens from the same group of strata, as well as from other rocks; which, together with collections procured from that region of country several years since, have enabled me to make some interesting comparisons between the faunas of the two localities.

* I only became aware of the existence of these collections in the latter part of 1856; and in consequence of the accessions from this and other sources, I have given more than a year of additional labor to the volume. Could these collections have been in my hands at the outset, it would have been greatly to the advantage of the work.

This department of the Geological Survey of the State was committed to my charge in 1843 : Vol. I was completed and published in 1847; and Vol. II, so far as regarded my own labors, was completed in 1850, and the work of the third volume was at that time in progress. In the spring of that year, legislative enactment removed the direction of this work from the Governor of the State, and placed it in the hands of the Secretary of State, who was "authorised and directed to take charge "of all matters appertaining to the prosecution and publication of the "Geological Survey of the State;" and in the third section of the same law, it was made "the duty of the Secretary of State and the Secre- "tary of the Regents of the University, to report to the next Legislature "a plan for the final completion of the said survey, and to submit the "estimate of the cost of such completion."

In a Report from this Commission to the Legislature, a proposition was made to pay the Palæontologist "two thousand five hundred dol- "lars" on the "presentation of each successive volume, commencing "with the third, to the Secretary of State;" which volume was to "contain the manuscript letter-press ready for printing, and be ac- "companied with the very fossils described."

This "proposition" was "deemed *a just and liberal one*," and it seems to have been anticipated that the work would go on under such conditions. The sum of money here proposed to be paid to defray the entire expenses of collecting the fossils and the study and description of the same, together with the labor of superintending the drawings and engraving, was in fact entirely inadequate to pay for the collection of the fossils necessary for a single volume, and left besides this more than four years of labor to be performed by the Palæontologist without any remuneration whatever. Under these circumstances the work could not go on, and it became by this act virtually suspended in the early part of 1850.

From the commencement of the work, the expenses of making the collections had been borne by myself. These collections, made up to that time, not only embraced most of those of the first and second volumes,

but the greater part for the third volume, as well as extensive collections in the higher rocks of the New-York series for the succeeding volumes. Besides these, I had made large collections of fossils in the same series of strata in the west, for the purpose of comparison with the New-York species. In this way, as well as in examinations of the rock formations *in situ* over a large part of the Western States for the purpose of determining the parallelism of the formations, I had already made great pecuniary sacrifices in carrying on the work. Under these circumstances, therefore, and with the new aspect presented by the law of 1850, and the action of the Commission relative thereto, I could no longer devote myself to its prosecution, and consequently made other arrangements for the occupation of my time, which, however, left me still some opportunity to continue my investigations in this work. As the contracts between the State and the engravers continued in force, the engraving, after 1851, was carried on somewhat slowly; my frequent and protracted absence rendering it impossible for me to give that personal attention to it which a work of this kind so fully demands. In order to prevent its entire cessation, I employed a person as an assistant (who afterwards became my draughtsman); the lithographer volunteering to contribute to pay a portion of the expense of such assistant, that his own work might not cease entirely. In this way the work was continued till 1855; no compensation whatever being paid to the author during this period.

In the latter part of 1854 and beginning of 1855, the attention of the then Secretary of State, Hon. E. W. LEAVENWORTH, was called to the consideration of this subject by Professor DEWEY of Rochester, who had taken some pains to procure information in relation to the state and progress of the work. Mr. LEAVENWORTH, with his enlightened views and the patriotic desire to see a work, which had been begun by a wealthy and powerful State, completed in a proper manner, inquired into its actual condition, and, finally, when I had decided to abandon it altogether, procured the passage of a law, giving to himself and the Secretary of the Regents of the University the power to make such contracts and provide such means as were necessary for carrying it on

to completion. This arrangement was consummated in July 1855; and thus after a suspension of more than five years on the part of the State, the progress of the work was again authorised.

This simple explanation, without going into any unnecessary details, or parading in this place the ruinous consequences to myself of this suspension of a work in which I had so heartily engaged and so freely expended my own means, seems required to account for the long-delayed appearance of the third volume.

In completing this volume, I have endeavored to do all in my power to make it a truthful record of the facts in my possession, and I trust it may be found in many respects more worthy of acceptance by the scientific public than its predecessors. Whatever may be the value or appreciation of this, or of any volumes which may succeed it, the public are indebted for the publication to the unsolicited action, prompted by an enlightened public spirit, of the Hon. E. W. LEAVENWORTH, whose inquiries into the condition of this department were counselled by one of the oldest and most honored teachers of science, and whose action was sanctioned by the approval of several of the most eminent scientific men of our country.

The printing of this volume was begun in 1856; and the descriptions of the greater part of the Lower Helderberg species were completed during that year and 1857, when the printing was suspended for nearly a year, mainly to enable me to incorporate in the volume the results derived from the study of the Cumberland and other collections, which are chiefly given under the Oriskany sandstone, and this part of the work was not finished till 1859.

Some of the plates of this volume were engraved before the completion of Vol. II in 1850*; a considerable number, between that time and 1855, while the work was not in authorised progress, except by the existence of contracts between the State and the engravers. The re-

* These are chiefly of the Gasteropoda, and may be known by the numbers having been added since the printing of the plates.

maining portion, much of which has been executed in a better style of art, has been done since 1855.

The volume of plates has been much longer delayed than I could have wished, and at the present time is not completed. This delay is in great part owing to the fact of ascertaining, early in 1858, that many drawings which I had entrusted to an experienced draughtsman to make, were entirely worthless from their inaccuracy, some of them even having been engraved, it became necessary to cancel the plates, and to redraw and re-engrave the subjects. While this has delayed the present volume, it has entailed upon myself no little personal expense and trouble, besides seriously hindering the progress of the work for the fourth volume. The later drawings will be found faithful and accurate in all the details, and I hope may offer satisfaction to the critical student in palæontology. For the perfection of these drawings, and for important aid in working out the details of structure in the new genera of Brachiopoda, much credit is due to Mr. R. P. Whitfield. I have been greatly indebted to Mr. John Paterson, for his supervision of the work during its progress through the press.

Considerable progress has been made in the work of the fourth volume; and should there be no interruption in the present arrangement, it will be published within a reasonable time. Owing to the cessation of collections for several years, much has still to be done in obtaining and preparing the materials for the work. Having, however, given especial attention to the Brachiopoda of the higher rocks, a preliminary notice of Vol. iv, so far as relates to this class of fossils, will appear in 1860.

INTRODUCTION.

So many years have elapsed since the publication of the second volume of the Palæontology of New-York*, that it becomes proper and necessary to preface the present volume with a short review of the results of the great progress since made in our knowledge of the successive rock formations, not only in regard to the higher groups, but also to those treated of in the previous volumes of this work.

Geological surveys, both public and private, have extended over large areas of the United States; and the very elaborate Geological Survey of Canada, under the direction of Sir WILLIAM E. LOGAN, has, more than all others during this period, contributed to our knowledge of the older formations.

Among the important and interesting vestiges of ancient life in the Potsdam sandstone, the investigations in the Canadian Geological Survey have brought to light the existence of footprints and trails, produced probably by crustaceans of several species, and some of them of large size. These trails, extending over wide areas of smooth surface, and associated with ripplemarks, furnish conclusive proof, if it were still needed, of the shallow condition of the ancient sea. It is even certain that these tracks are in part or wholly subaerial, since the action of the wind is clearly shown upon the ripplemarked surfaces.

Soon after the publication of the first volume of the Palæontology of New-York, the surveys of Dr. D. D. OWEN in the northwest had made

* This volume bears the date of 1858; but so far as regards the completion of the work, except the preface, it was finished in 1851.

known to us the existence and wide extent of a sandstone, which he at that time regarded as far below the Potsdam sandstone of New-York. This rock, moreover, charged with lingulæ, trilobites, etc., showed a much more prolific fauna than the Potsdam sandstone was at that time known to contain. A personal exploration in 1850, and an examination of the localities named by Dr. OWEN, enabled the writer to place this rock in the same horizon with the Potsdam sandstone, and in fact to demonstrate its continuity with the more eastern deposit of this age, by tracing it along the lower limits of the Silurian basin, from Canada West on Lake Huron, to the Mississippi and St. Croix rivers in Wisconsin.

The results of these examinations were published, under the writer's own name, in the Report of Messrs. FOSTER and WHITNEY upon the Lake Superior Land District in 1851.

Dr. OWEN subsequently adopted this view of the age of the sandstone, and has thus published it in his final Report in 1852.

The great interest of this formation in the west, is the occurrence of several species of trilobites in beds which mark certain horizons in the formation. The trilobites are referred by Dr. OWEN to several genera which he has constituted to receive them, though the forms in many instances bear strong resemblances to known genera. The broken and comminuted remains of these trilobites are distributed over an extent of more than two hundred miles along the Mississippi river in greater or less profusion; and they are every where found, until the sandstone disappears beneath the river in the northern part of Iowa.

The lingula beds are almost equally extended, though not so prolific in all parts of this range. At the falls of the St. Croix river, more than half the material of the rock appears to be composed of these shells. Towards the south, the beds still continue; but the shells are broken and comminuted, and are drifted together precisely in the same manner as we find seashells upon a modern beach. Here, again, over this wide area, and a thousand miles from the eastern known limits of the sandstone, we find the most unequivocal evidences of a shallow sea.

It is of much interest that this early sediment presents such a uniform, even monotonous physical character, over the wide areas in which it has been investigated in New-York, Canada, Pennsylvania, Virginia, Iowa, Wisconsin, and Minnesota.

The proportion of calcareous matter in the Potsdam sandstone at the west and northwest, is much greater than in its eastern localities. This is particularly manifest in some parts of the trilobite beds, where the rock has often, for several feet in thickness, the character of a silico-argillaceous limestone. While in its eastern localities, the Potsdam sandstone is usually a hard and compact rock, enduring the action of weather in a very high degree, it becomes at the west a friable, sometimes incoherent mass; and though presenting high perpendicular cliffs, surmounted and protected by the cherty beds of the next succeeding formation, it is usually unfit for all economical purposes, crumbling into fine sand on exposure to the frost and sun.

From what we already know of this rock in the west, we are prepared to believe that some more fortunate localities will yet furnish numerous and satisfactory examples of its fauna. Thus far, the trilobites are fragmentary; the character and condition of the beds in which they occur point to westerly or southwesterly currents, by which they were brought to their present position. In these directions, therefore, we may probably look for the highest evidences of the characteristic fauna of this period.

I should not omit to mention, that shells of Brachiopoda and crinoidal columns have been found in this sandstone in the northwest*. None of these have fallen under my observation; and from the fact that they are not figured and described in Dr. OWEN'S Final Report, we may infer that they were in too imperfect a condition to be specifically recognized. Among the thousands of Lingula which I have examined from the beds on the St. Croix river, I have discovered no trace of any other shell. Indeed the character of the sediment generally is such as would apparently preclude the existence of other brachiopodous molluscs.

* See OWEN'S Report, 1848, page 15; and 1852, page 499.

The occurrence of such vast numbers of lingulæ in this rock renders extremely interesting and significant the late discovery of Mr. T. Sterry Hunt, that the shells of all lingulæ are composed of phosphate of lime. This offers an explanation of an apparent anomaly before observed in regard to these shells, showing that the conditions favorable to or admitting their existence may preclude that of other molluscs. Thus we have conclusive evidence of the occurrence of lingulæ in the Potsdam sandstone, often in great numbers, and extending over an area of country more than one thousand miles from east to west, and from three to five hundred miles from north to south; while not a single other shell has been published to the world from the same rock over this wide area. The harsh arenaceous beds of this ancient sea deposit, from Canada to the Mississippi river, we find, with few exceptions, nearly destitute of calcareous matter, and capable only of supporting the existence of this enduring little animal, covered with its phosphatic shell, itself almost as hard as the siliceous grains amid which it lies entombed.

The Potsdam sandstone, in Iowa, is often composed of rounded or oolitic granules in its higher beds; and the beds of passage to the succeeding rock are frequently of such a character that we must suppose them to have been largely formed from silica in solution, or from gelatinous silica.

The investigations made in the Canadian Geological Survey show that the Calciferous sandstone is, in some parts, more highly fossiliferous than in any previously known localities. The new forms, however, are few, and present no wide departures in type from those before recognized. The *Ophileta* (*Euomphalus?*) *complanata* is sometimes extremely abundant, hundreds of individuals occurring in a single locality.

These variations are doubtless in a great measure due to the different characters assumed by the rock in different places. In the States of Wisconsin and Iowa, and the Territory of Minnesota, this rock has proved quite as poor in fossils as it is in the State of New-York, and has furnished fewer species compared with the area of its outcrop and exposure. In that part of the country, the rock is highly magnesian, and is likewise much

permeated by silica, which has had the effect in many instances of nearly obliterating the organic bodies. In Central New-York, the porous character of this sandstone, with its numerous small irregular cavities, often lined or filled with quartz crystals, or permeated by siliceous veins, has left the fossils in an obscure and imperfect condition.

In addition to the instances in Canada, we have some evidence that this formation is fossiliferous in its more northerly extension at the west; since a piece of the rock found upon the Menominee river was completely filled with fragments of fossils, principally of trilobites. In this example, the rock is highly calcareous, with a distinct intermingling of grains of sand, but containing no cherty matter or seams of silica, and is entirely free from the small cavities so common in this rock elsewhere.

Farther to the south, in the State of Missouri, the Calciferous sandstone contains numerous fossils, bearing the general character of those given in the first volume of the Palæontology of New-York; while many are of distinct specific forms. The extensive outcrop of this rock in Missouri, connected with the fact that it is there also the lead-bearing rock, give great facilities for exploration; and we shall soon have the means of knowing more fully the nature of the fauna of this ancient formation, both in Canada and Missouri, at points more than twelve hundred miles distant from each other.

In the table accompanying the first volume of the Palæontology of New-York, showing the vertical range of the fossils in the different groups, all those of the Potsdam sandstone and Calciferous sandstone were found to be restricted in their geological range to these rocks*. Although a meagre fauna, as there presented, it nevertheless furnished presumptive evidence in favor of uniting these formations as a single group. All subsequent investigations have corroborated the previous facts, and sustain this view of the relations of these two rocks, and their distinction from the groups above. Between these lower beds and the succeeding rocks,

* The single exception indicated in the volume is a specimen, the locality of which is uncertain.

which include the limestones of the Trenton period, few affinities are observed; until we find in the shales of the Hudson-river group some remarkable species which show analogies with those below. Altogether, however, depending upon the fauna we possess, we are ready to conclude that a total organic change supervened to the final deposition of these lower masses.

In Iowa and Wisconsin, the junction of the Potsdam and Calciferous sandstones is marked by alternating beds or bands of the two rocks; showing a repetition at short intervals of the previously existing conditions, and that the causes giving rise to the arenaceous deposit of the Potsdam sandstone did not cease with the commencement of the calcareous formation succeeding it. These alternating bands of the two rocks, though marked in the outcrop as very distinct, are nevertheless found on closer inspection to present gradations from one to the other which are nearly imperceptible, except where the deposition succeeding the sandstone is of cherty matter. This being a chemical rather than a mechanical deposit, presents in consequence an abrupt change in the characters of the material.

Again, farther to the south, in the State of Missouri, we find exhibited results of the operation of similar causes in a far more extreme degree*. Here the Calciferous sandstone (or, as it is termed in the Report, the Magnesian limestone), instead of occurring mainly as one interrupted formation with some comparatively unimportant alternations at its base, is subdivided into four principal masses. These are each separated from the others by beds of saccharoidal sandstone, having a thickness of from 50 to 100 feet; while the intervening calcareous masses have a thickness respectively of 190, 230, 350, and 300 feet. We have here the most satisfactory evidence that conditions producing the Potsdam sandstone recurred at long intervals throughout the period from the commencement to the final deposition of the Calciferous sandstone.

At the close of this period, although important modifications occur in

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* See the Report of Prof. SWALLOW upon the Geological Survey of Missouri, 1855.

the fossil characters, we have little evidence of any great physical change. In the State of New-York, the Chazy limestone, which succeeds the Calciferous sandstone, often presents in its lower divisions evidences of a continuation of the same conditions as prevailed during the deposition of the preceding rock. The lithological aspect of some of the beds is precisely similar to that of the Calciferous sandstone, showing that the waters charged with the same materials still flowed over the ocean bed of the Chazy period. Nevertheless in some other localities within New-York there appears a slight unconformity between the Calciferous sandstone and the succeeding rock; but this appearance may be attributed to the absence of a portion of the limestone beds, permitting the Birdseye limestone to rest directly upon the sandstone.

In the northwest, on the contrary, there are many evidences of physical change. There, the Calciferous sandstone is often, through a thickness of forty or fifty feet or more, a huge mass of breccia. The materials of the rock appear to have been broken up, while partially indurated; the interstices are often filled with sand; and fragments of friable sandstone, from the weight of an ounce to several pounds, are found mingled with the broken rock itself. In some instances these fragments of sandstone present lines of deposition, and sometimes of discordant lamination, showing that they have been torn from masses of rock previously indurated. These phenomena occur at several points along the Mississippi river; and however local they may be in their extent, they point to a disturbed condition in the surrounding ocean, which must have been highly unfavorable to the continuance of the previously existing fauna.

From the circumstance that these conditions of the rock have been noticed only in the west, we are prepared to find the source of disturbance in that direction, and probably beyond the limits to which our examinations have extended.

It should not be forgotten, moreover, that at the west, and throughout the great exposure of the Calciferous sandstone in the Northwestern States, it is everywhere succeeded by a homogeneous light-colored sandstone,

differing little in its general characters from the Potsdam sandstone which lies below, except perhaps in a lighter color and more friable and incoherent texture.

So far as observed, there are no alternations of the Calciferous with the sandstone which succeeds it; though where the former is broken up, and presents the brecciated character before described, fragments of the higher sandstone are mingled in the interstices throughout the rock below. There are, moreover, sometimes evidences of faults or down-throws of the lower rock, by which the higher sandstone is brought into a lower position.

In its eastern extension, this upper sandstone thins out somewhere in the northern part of Wisconsin, or the adjoining State of Michigan, since it has no existence in a section along the Escanaba river, on the north of Lake Michigan. It may also be stated, that in the general thinning out of all the lower limestones, the Chazy limestone is scarcely recognized west beyond the great northern curve of these rocks about the head of Lake Michigan.

It will be observed, therefore, that this upper sandstone of the west holds in the series precisely the place of the Chazy limestone, as will appear on comparing the column of strata in New-York with that in the west:

New-York.	Iowa, Wisconsin and Minnesota.
Trenton limestone.	Trenton limestone.
	Galena limestone.
Black-river limestone.	Black-river limestone.
Birdseye limestone.	Birdseye limestone.
Chazy limestone.	Sandstone of the Chazy period.
Calciferous sandstone.	Calciferous sandstone.
Potsdam sandstone.	Potsdam sandstone.

While in New-York and Eastern Canada the conditions giving origin to the Calciferous sandstone were succeeded by seas capable of sustaining a numerous fauna, with coral reefs and all the phenomena attendant upon the great limestone formations, this period at the west was followed by precisely a repetition of the conditions which preceded the deposition of

the Calciferous sandstone. Thus in place of limestones, we have a widespread arenaceous deposit, destitute of organic remains. This later deposit of sandstone in the northwest, though usually no more than from fifty to eighty feet in thickness, becomes of extreme interest in considering the physical conditions there existing. While the ocean in its eastern extension was in a quiescent state, and inhabited by numerous forms of animal life, the same ocean a thousand miles westward was the scene of disturbances which abraded the arenaceous materials of an ancient land, and spread them eastwardly over its bed.

We would naturally infer that the deposits of the same age on the eastern side of the ancient ocean would bear some traces of disturbances so great as those which were taking place on the west; and accordingly we find that in the midst of the Chazy limestone there is intercalated a thin bed of light-colored sandstone, and there are likewise some more argillaceous bands charged with numerous marine plants.

If our conclusions regarding the equivalency of these two formations be correct, we have at one extremity of this oceanic area a destitution of organic remains, while at the other, life was abundant, except for a short period, when the influx of arenaceous and argillaceous material degraded the conditions below those required for the support of animal life.

The section of these beds, as they occur in Missouri, does not show any sandstone immediately succeeding the Calciferous sandstone, as in the States north of it; but, on the contrary, that rock is here followed directly by the Birdseye and Black-river limestones. The absence of the Chazy limestone is also distinctly shown in the section given in the Missouri Report.

While these investigations in the north and west are bringing to light new forms of this ancient fauna, we learn that the *Paradoxides harlani* has been rediscovered in the ancient metamorphic slates of Eastern Massachusetts, in a part of the country from which no fossils have heretofore been obtained. Although we do not yet know the precise equivalency of these slates, we have some reason to place them in the same horizon

with certain shaly beds in the Potsdam sandstone, or even perhaps at the base of this formation*.

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* The rediscovery of this trilobite in an authentic locality, after a lapse of so many years, is extremely interesting. The *Paradoxides harlani* was described by Dr. GREEN in the Supplement to his Monograph in 1835, from a specimen belonging to the Cabinet of FRANCIS ALGER, esquire, and believed to be from an undoubted American locality. Since no other specimens have been seen, some doubt had arisen as to the American origin of the one in question; and since the original has been lost, no other representations of it remained except the cast of Prof. GREEN. The specimens now obtained from Braintree are imbedded in a rock of precisely the character of the original specimen obtained from Mr. ALGER, which the writer well remembers seeing in the possession of Dr. GREEN.

During this interval, fragments of trilobites have been several times found upon George's island in Massachusetts bay, but they do not appear to have attracted the attention of the naturalists of the vicinity.

The history of the present discovery appears to have been as follows :

"About five years ago, Mr. ELIPHAS HAYWARD first observed these fossils on opening his stone quarry for the purpose of obtaining underpinning and ballast stones. Without knowing their nature, he still looked upon them as interesting curiosities, and laid aside the specimens which have lately been brought before this Society.

"He showed them to PETER WAINWRIGHT, esquire, of Boston (Mass.), who at once recognized them as trilobites, and brought them to Boston for the inspection of geologists, and presented two specimens to our associate Prof. WILLIAM B. ROGERS, to whom the Society is indebted for the first notice of these remarkable fossils, so important in the determination of our geognostic horizon.

"A few days after Prof. ROGERS's visit to the quarry, Dr. JACKSON, by invitation of Mr. WAINWRIGHT, visited it and made a minute examination of all the geological phenomena which it presents, and obtained specimens of the trilobites through the kindness of Mr. HAYWARD, and by search at the quarry in company with Mr. WAINWRIGHT. Two specimens were obtained; one entire, which is 8¼ inches long and 4 inches wide. The other, of which only the head and half the body was obtained, is 6 inches wide, and its hood is 7¼ inches across by the base of the head : hence the length of this specimen must have been 12½ inches at least, which is about the size of the largest specimens of the *Paradoxides tessini* discovered in Sweden. The smaller individual has 21 articulations, but none in the tail beyond the lateral appendages, and in this respect differs from the *P. tessini*, its nearest analogue, which has, according to BRONGNIART, four faintly marked depressions or folds crossing the tail transversely. They may have been obliterated in our specimen by the changes the rock has undergone.

"These trilobites of Braintree occur in a blue gray argillaceous slate, containing silicate of lime, but no carbonate, and some disseminated iron pyrites. The stratification of the rock, as indicated by its grain and cleavages, dips to the north 50 degrees, and runs east and west. It is but slightly altered by heat in those portions where the trilobites are found; but near the sienite rocks, it is filled with nodules of epidote, and closely resembles the altered slates of Nahant. There is a small vein of quartz, bearing iron pyrites in it, which cuts through the slate strata at right angles. There are also slickensides surfaces on some of the cleavages or joints in the quarry; indicating, as it is supposed, the polishing effects of rapid earthquake movements at the period of disturbance of the strata at the time of their disruption by intruded sienite.

"These are all the marks discoverable of metamorphic action of igneous rocks on these sedimentary strata, though the slate rocks are hemmed in by the sienite rocks on both sides, and the belt of slate is quite narrow*."

A notice of this discovery has likewise been published in the American Journal of Science and Arts for September 1856, by Prof. W. B. ROGERS, who also read a notice of the same before the American Association for the Advancement of Science.

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* Extract from a Report made to the Boston Society of Natural History by Dr. C. T. JACKSON.

In regard to the preceding formations, constituting the Potsdam and Calciferous sandstones in their various phases, we have already sufficient knowledge of the characteristic fossils to show that the fauna of this lower division of our palæozoic series corresponds in many respects with that designated by BARRANDE as the "Fauna Primordiale" in Bohemia.

The rocks and groups of the Second Great Period, as determined by the relations of its fauna, consist of the following:

7. Hudson-river group.
6. Utica slate.
5. Galena limestone.
4. Trenton limestone.
3. Black-river limestone.
2. Birdseye limestone.
1. Chazy limestone.

The first member, as already stated, is absent over a large part of the western and northwestern country, while the second and third members are likewise frequently very thin or altogether absent. We have learned, moreover, that the fossils characteristic of the Trenton limestone do sometimes appear at a lower horizon than had been supposed, while some of the fossils of the lower members occur in the Trenton limestone. In that part of the country we occasionally find fossils of the Black-river and Trenton limestones mingled together, with one or two forms of lower species, in a rock possessing the characters of the Black-river limestone. The investigations in the Canada Geological Survey show that certain parts of the limestone formation contain many of the Black-river and Trenton species, intermixed in the greatest profusion.

The lines of demarcation, therefore, between these different rocks, are not everywhere so well defined as in certain parts of New-York. Nevertheless the value of these subdivisions remains, since we find no difficulty in recognizing the Black-river and Birdseye limestones at numerous points, through New-York and Canada, by the northern margins of Lakes Ontario, Huron and Michigan, and thence across Wisconsin to the Mississippi river,

and up this river as far north as the Falls of St. Anthony in Minnesota. In Wisconsin, Iowa, Illinois and Missouri, the same formations are recognizable, and everywhere marked by a few peculiar species. In Kentucky, the same is true of these limestones; and even in Tennessee, where the great tenuity of all the older rocks causes an apparent mingling of several formations, these divisions are still to be recognized.

From the St. Mary's river on the north, to the Mississippi, I have personally examined these beds at numerous points, as likewise in the southern part of Wisconsin, in Iowa and Illinois; and though the thickness of each member is rarely more than a few feet, I have never failed to recognize more or less clearly the lithological characters by which each is known in New-York, and likewise some of the more characteristic fossils. When followed in a westerly or northwesterly direction, there appears to be a gradual thinning out of these deposits, an increase of argillaceous matter, and an almost entire absence of the corals proper; a few of the Bryozoa still continuing. This fact is in harmony with the conditions affecting the Chazy limestone, which thins out, as before stated, somewhere in the vicinity of the Escanaba river, on the north of Lake Michigan.

The Trenton limestone proper, which gives character to the entire period, is the most persistent of the different calcareous members. Large accessions have been made to our knowledge of its extension and character in other parts of the country, since the publication of the first volume of the New-York Palæontology. The Geological Survey of Canada has shown its wide extent upon the north and northwest, both in the Lower and Upper Provinces. In its western extension, it shows, in like manner with the limestones below, a gradual diminution in thickness, a larger proportion of intercalated shaly laminæ and beds, and a decreasing number of fossils. Nevertheless it maintains sufficiently its lithological aspect to be recognized everywhere; and even throughout the entire distance from the Hudson to the Mississippi, it contains enough of its characteristic fossils to be identified. It is well marked on the northern shores of Lake Huron and

Lake Michigan; in Wisconsin; in Minnesota, at the Falls of St.Anthony; and at numerous points along the Mississippi both in Iowa and Wisconsin, as far south as Dubuque. It reappears along the river in Illinois above Point au Gris with even more of its characteristic features, both in fossils and in lithological characters, than in the more northern localities in this valley. Still farther to the south, along the Mississippi valley, this rock assumes more and more the aspect which it possesses in New-York : its thickness increases; and in all its characteristics it assimilates to the rock in its normal and best developed condition. In numerous localities in Missouri, the Trenton limestone presents an important development, and everywhere contains characteristic fossils. Both in Kentucky and Tennessee this limestone has comparatively a very extensive development; more particularly in the latter State, where it contains many of its characteristic fossils.

With all this additional information in regard to the extension and development of the Trenton limestone, we have no knowledge of any localities of equal perfection with those of Central New-York. No others have yet shown the rock so perfectly developed in all its phases of lithological character, and from no other point have we obtained so great a number of fossil species. Still, among the Crinoideæ and Cystideæ comparatively few species have been found in the rocks of this period in New-York, or in the Western States. So far as I know, not three species have been added to those described in the first volume of the Palæontology of New-York; and from the numerous collectors now at work upon this rock in different localities, we should expect them to be discovered, if really existing. In the mean time, a single locality on the Ottawa river has yielded to the investigations of Mr. Billings, now of the Canada Geological Survey, more species of crinoids and cystidians than all the Lower Silurian rocks of the American continent besides, and even more than all from strata of the same age in Europe and America together. It is probable that other families of fossils may prove equally abundant in

some localities in Canada, especially bordering the north side of the St. Lawrence and Lake Ontario*.

We shall, probably, yet find it convenient to indicate several subordinate divisions in the Trenton limestone, where that rock is best developed, marked by the prevalence of certain species, and the almost entire restriction of these species within narrow limits.

The group of strata known as the Hudson-river group, which in its more extended signification may include all the beds from the Trenton limestone to the Shawangunk conglomerate, has afforded in New-York but small additions to the number of fossils previously known in this formation. From the metamorphic slates of this group on the western slope of the Green mountains in Vermont, we have three or more species of trilobites, which are of much interest, being representatives of a genus but little known in this country. The slates of the same age farther to the south have yielded some additional new species.

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* In some parts of Canada the fossils of the Trenton limestone are completely silicified; and the shells thus preserved are often weathered out so as to show their characters of hinge, etc. almost in the same perfection as in modern shells. The same result is accomplished by dissolving away the limestone by acids, leaving the silicified shell entire. In this manner specimens have been obtained, showing the characters of hinge and teeth, in *Tellinomya*, *Modiolopsis*, *Ambonychia* and others. These characters are such as to leave no doubt regarding the true relations of these fossils.

The Genera TELLINOMYA and MODIOLOPSIS have been referred by M. D'ORBIGNY to LYONSIA, and the species are placed under that genus in his "Prodrome de Paléontologie." The distinctions between these genera were originally founded, chiefly, upon external characters; but we now have the means of showing the internal characters of these shells, which prove them not only entirely distinct, but in both instances widely different from *Lyonsia*. The former proves to be closely allied to *Nucula* (and will include several species previously arranged under that genus); all the species examined having a continuous series of crenulations along the hinge line, and an external ligament, while the species of *Modiolopsis* have no serial teeth or crenulations of this kind in the hinge.

The Genus *Ambonychia*, regarded by M. D'ORBIGNY as equivalent to *Posidonomya* of BRONN, proves to be quite as distinct from the latter as *Tellinomya* is from the former.

In the mean time, a writer, professing to give an account of the present state of American geology, has copied the list of fossils from the work of M. D'ORBIGNY (acknowledging his indebtedness to that author for *a corrected list of American fossils*), entirely regardless of the relations of these and other fossil genera; and, obtaining possession, without authority, of illustrations made for the author's own work, he has carelessly used them to propagate these false impressions concerning the fossils of the rocks of New-York and the United States. But for this circumstance, the present writer would not have animadverted upon the jumbled production which its author has had the self-complacency to designate by the comprehensive title of "American Geology"!

In Canada, however, have been made the greatest accessions to our knowledge of the fossil forms of this period. In certain localities, the slates of the higher part of the group have yielded large numbers of graptolites, in such a state of preservation as to show, for the first time, the true structure of this fossil. The specimens heretofore figured and described, prove to be for the most part mere fragments or single rays, which, separated as they usually are in the rock, give no true idea of the form and mode of growth of the original animal. The extensive collections made in Canada, besides giving this information, furnish some ten or twelve new species*.

In addition to the graptolites, several new species of *Dictyonema* occur in the same shales, in such associations and in such condition as to prove very conclusively the truth of the suggestion that this genus should be placed among the Graptolitideæ†. The same collections likewise furnish two additional genera belonging to this family.

The opinions advanced by the writer in 1844 and 1845, and published in the first volume of the Palæontology of New-York, relative to the age of the rocks composing the metamorphic belt on the east side of the Hudson river, and including the principal part of the Green mountain range, has been fully confirmed by Prof. ADAMS in the Geological Reports of Vermont. A re-examination of some portions of the same belt has added fresh evidence of the age of the formations, so far as included in Eastern New-York, Western Massachusetts, and Vermont.

In the Canada Survey, also, this problem has been wrought out with a care and accuracy in the details which lead to the greatest certainty, not only in the general result, but equally in reference to individual members of the group. In this region, which is an extension of the Green mountain range to the northward, the formations acquire an enormous development,

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* Among the species described and figured in the first volume of the Palæontology of New-York, the *Graptolites sextans*, *G. furcatus*, *G. serratulus*, *G. gracilis* and *G. bicornis* are almost the only species that indicate the mode of arrangement of the parts; and these species alone could never have given us a true idea without farther discoveries.

† Palæontology of New-York, Vol. II, p. 174.

and present on a more extended scale all the phenomena which have been described as occurring in localities farther south. In tracing the formations still farther to the north, the highly inclined, folded and contorted stratification of these shales, conglomerates, and limestones, gradually disappears; the metamorphic condition declines in the same ratio; until the strata assume nearly their normal condition and position, and exhibit unequivocally the characteristics of the Trenton limestone and the Hudson-river group.

A similar change in the character of these rocks has been before shown, in tracing the strata westward from the Green mountain range; in which direction the foldings and the metamorphism gradually disappear, till the rocks assume their normal condition. In Canada, however, this change is not to the west or the east of the trend of the metamorphic chain, but in the continuation of the chain itself to the northeast, and in the trend of its greatest elevation, disturbance, and metamorphism; showing that all the phenomena exhibited in the Green mountain range are superinduced upon the rocks of the Trenton and Hudson river periods. Not only has the general identity been thus determined, but individual beds of the metamorphic belt have been traced in their line of strike till they assume their normal aspect.

Nor have the investigations rested here: for the chemical examinations of Mr. T. Sterry Hunt (of the Canada Geological Survey) have shown that the unaltered beds contain the same mineral components, and in the same proportions, as do the altered beds.

The great serpentine range of rocks, which are known to belong to the upper part of the Hudson-river group, have been proved to correspond in chemical character to the unaltered rocks lying in the same geological position, and identical with the continuation of these beds*. Geological structure, therefore, and chemical and palæontological evidence all unite in proving the age of these deposits.

* I need only refer in this place to the elaborate Reports of Progress in the Canada Geological Survey, and to the various Essays by Sir W. E. Logan and Mr. T. S. Hunt, for the proof in detail of what is here stated.

This group of strata, elsewhere described as consisting of shales, shaly sandstones, sandstones and conglomerates, presents in its western extension a very different aspect. In tracing the direct continuation of the same rocks through Canada West, and by the northern side of Lakes Huron and Michigan, the arenaceous portions gradually disappear, the shales become lighter in color, and an accession of calcareous matter gradually takes place. In the Manitoulin islands of Lake Huron we find the higher parts of the group represented in great measure by beds of limestone separated by shaly seams, and abounding in that very characteristic coral *Favistella favosa*. The arenaceous portions of the group in this region consist of a few thin and very subordinate beds of argillaceous sandstone containing fucoids; the prevailing character being that of calcareous shales, with thin laminæ of limestone. The lithological aspect of this group, as it is seen on these islands, at Point aux Baies on Lake Michigan, and on the shores of Green Bay, is the same as at Cincinnati, where the group is known as the "*Blue limestone*"*.

More recently, in 1855, I have had an opportunity of proving the existence of this group at numerous points along the Mississippi river, where its relations to the underlying and superior rocks leave no question as to its relative position.

As already described, this group, at the Manitoulin islands of Lake Huron, on Green Bay, at Cincinnati and elsewhere, consists of calcareous strata with intercalated laminæ or thin beds of limestone, and is highly fossiliferous; abounding in several species of *Orthis*, *Leptæna*, etc. Until 1855, its existence had been overlooked upon the Upper Mississippi; but I am now able to prove its occurrence in numerous localities in Northern Illinois, Wisconsin and Iowa. In these places, however, it consists almost entirely of calcareous soft shale or clay. The fossils are confined to two or

* This formation, as it appears at Cincinnati, and at Madison (Indiana), I first made known in 1841 (American Journal of Science, vol. 42) as the equivalent or continuation of the Hudson-river group; but was subsequently induced to yield this opinion, and have admitted its fossils into the Trenton period, in the first volume of the Palæontology of New-York. Later examinations, made in 1850 and 1851, have shown conclusively the correctness of my first published opinion in regard to the age of these rocks.

three bands of the rock near its base, which are mostly made up of *Tellinomya*, *Lingula*, *Orthoceras* and a small *Orthis*, with fragments of shells and some small concretions. The group has altogether diminished, so that it is scarcely one hundred feet thick; and in many localities the characteristic species of the group, *Orthis*, *Leptæna*, etc. are entirely absent, while in a single locality a few specimens only were found.

The extreme attenuation of this group, and its position between the Niagara limestone above and the Trenton limestone below, has caused it to be overlooked. In Southern Wisconsin and Northern Illinois, as well as in some parts of Iowa, the shales of this group form the slopes of the mounds, such as Blue Mound, Sinsinawa Mound, Pilot Knob, etc. The base of the hills consists of the Trenton or Galena limestone, while the upper part is of the Niagara limestone, including perhaps some higher strata; while the slope, being superficially covered with fragments of limestone from above, has likewise been included in the same, and the whole elevation of these mounds set down as limestone*. I have learned, however, that in all these there is from 75 to 100 feet, and possibly in some instances more, to be estimated as shales of the Hudson-river period; giving a geology to these parts of the country different from that heretofore known.

The belt of outcrop of the shales, in that northwestern country, is always marked by springs of water, by a greener vegetation in autumn, and by the presence of clay beds. These are often the locations of brick-kilns, as the decomposition of the shale produces a very adhesive clay.

Where denuded of the limestones above, the outliers of these shales give the gentle eminences and graceful undulations to some parts of the prairie country, so well illustrated in some of the sketches accompanying the Reports of Dr. Owen, where the prevailing underlying rock is the Trenton or Galena limestone; while the conspicuous outliers of the "*Upper Magnesian limestone*" there represented, with abruptly sloping hills below,

* Reports of Progress 1844 and 1848, and Final Report 1852, of Dr. D. D. Owen, upon the Chippewa Land District.

are outliers of the *Niagara limestone* resting upon the shales of the Hudson-river group, which, in their denudation, have left the limestones above in columnar and castellated masses.

On the west of the Mississippi river, the group continues to diminish; and towards the northern outcrop, I have obtained no sections beyond twenty-five or thirty feet in thickness.

On descending the river, the shale augments, and the calcareous bands become characteristic. At the same time this change is accompanied by the presence of *Orthis occidentalis*, *Leptœna alternata*, *L. filitexta* and *Atrypa increbescens*. The fossiliferous bands of the more northern localities contain abundance of *Tellinomya* (*Nucula*) *levata* (which is often collected in great numbers from the soil along the outcrop), *Lingula quadrata*, a small species of *Orthis*, and sometimes many *Orthoceratites*. Those fossiliferous bands are usually near the base of the formation.

In Missouri, this group is estimated by the State Geologist at one hundred and twenty feet; and in some localities visited by myself in that State, I have seen from seventy-five to one hundred feet in thickness. Its most extreme attenuation appears to be in the northwesterly direction, where in some parts of Iowa it is less than fifty feet thick, and probably dies out entirely within the limits of that State.

This group offers a very interesting exhibition of the phases presented by a sedimentary deposit, when traced over a wide extent of country. In the eastern townships of Canada, this group, including its sandstones and conglomerates, and the Sparry limestone of EATON, is six or seven thousand feet in thickness. Following it to the southward, it gradually diminishes, but, according to the Geological Report of Pennsylvania, is still six thousand feet thick in that State.

Upon the borders of Massachusetts, it would appear to constitute from two to three thousand feet of the elevation of some of the mountains, as Saddle mountain and others; while in New-York, its greatest thickness where undisturbed is probably not more than fifteen hundred feet, and where interrupted by the valley of Lake Ontario in Oswego and Jefferson

counties, it is much thinner*. Continuing in the same direction through Canada West, there is very evidently a gradual and constant attenuation, which takes place in a great measure from the disappearance of the coarser materials of the group.

The Sparry limestone of Prof. EATON, which forms so striking a feature in the eastern and northeastern extension of this group, is almost entirely absent where the strata are exposed on the two sides of the Mohawk valley, and in the counties of Lewis, Oswego and Jefferson. This rock, however, is conspicuous in Rensselaer and Washington counties, and still farther north in Vermont; but it appears to reach its fullest development only in Canada, where it presents some very interesting and remarkable features. It occurs more or less mingled with, or interstratified among the slates of this part of the group, not only in continuous heavy masses, but in a kind of conglomeratic or brecciated condition. These beds of limestone are not uniform in character : some of them, weathering to a dingy brownish color, are found to be magnesian limestones; while others are destitute of magnesia, and of the same character as ordinary limestones, though usually non-fossiliferous. It is these magnesian and brecciated limestones that have been proved to form the serpentines of Northern Vermont and the eastern townships of Canada.

The Hudson-river group, though spreading far to the westward, nevertheless maintains its greatest thickness in the direction of the Appalachian chain. In this direction have accumulated the immense amount of its coarser materials; and we may conceive of that range as indicating the pre-existence of a long coast line from which these materials were abraded, forming a submarine belt of sediments in some degree parallel with the outline of an ancient continent on the east. The force of the current, which was sufficient to bring in this vast quantity of sedimentary matter, extended westward with diminishing force, precipitating the finer mud so slowly as to permit the incipient growth of coral reefs along an equal extent of the ocean bed. Thus from the St. Lawrence on the north,

* The usual estimates of the thickness of this group in Central and Northwestern New-York are from 800 to 1000 feet.

That isolated and almost unknown land, Anticosta, has, during the present year, furnished from the same group, and from the succeeding strata, large collections of fossils which prove an almost an entire absence of the arenaceous and coarser sedimentary deposits at that point, while the conditions appear to be almost precisely like those exhibited in Ohio and Indiana. Some of the same species of fossils occur in equal or greater abundance; the lithological characters are the same, and coral reefs appear to have formed long barriers in this ancient sea; while the line of the coarser sediments lies to the southeast, trending away through New-Brunswick, Nova-Scotia and Newfoundland, to the North Atlantic.

Both to the west and east, therefore, of our meridian, were coral seas, abounding also in brachiopods and their usual associates of cephalopods and gasteropods, living in a calcareous mud, and upon a comparatively quiet ocean bed; while to the east and southeast of these zones, a vast area of the same ocean bed was overspread by coarser materials, abraded from an ancient eastern continent by currents of that primeval ocean.

Along the shores of this ocean, in a direction from northeast to southwest, from Newfoundland to the southern extremity of the Laurentian mountains, and thence from Canada to Alabama, were spread these immense sediments along the line of the present mountain ranges; while on the northwestern and western sides lay the quiet ocean teeming with its inhabitants, and scarcely disturbed by the gentle currents which transported the fine and almost impalpable mud, which in its extreme extension may have reached a thousand miles from the centre of the great accumulation. Interrupted as this area was by the southern extension of the Laurentian into the line of the coarser sediments, and which thus cut off the continuity of the more quiet deposits on the east and west, yet nevertheless the conditions on the two sides were very similar. On both sides we find that widely distributed coral *Favistella stellata*, with other corals and numerous species of brachiopoda and other shells, which, in the intermediate belt of arenaceous and shaly deposits, several hundred miles wide, have not been observed.

conglomerates described by Sir W. E. Logan in the Geological Survey of Canada.

At the west and southwest the upper beds are often calcareous, with more rarely arenaceous and calcareous strata in the higher part of the group. The transition to the succeeding formation is always strongly marked; and it is only in rare instances that we have seen beds of passage, with a few of lower species of fossils.

In the very heterogeneous assemblage of materials and fauna which constitute the Medina sandstone and Clinton group of the New-York series, we have an indication of the recurrence of the causes which produced the Hudson-river group, operating apparently in conjunction with other forces, which have finally culminated in the Niagara group. The evidence of sudden alternation and violent change exhibited in the Clinton group in New-York, long made it a very difficult and unsatisfactory study. The mingled character of its materials, and the very evident relation of its fauna with both lower and higher strata, left the results quite uncertain, with a strong indication that there was something more to be learned concerning its relations with the preceding and succeeding formations.

With this idea I have followed the line of its outcrop in Canada West, upon the islands of Lake Huron, along the shores of Green Bay, and through Wisconsin. Examinations in all these localities have afforded no additional information beyond what we possessed in New-York. While the Medina sandstone can be identified only in a few points, the Clinton group is more persistent; and with its soft shales and associated iron ores, its beds of sandstone and impure limestone, it is clearly recognized in the State of Wisconsin. The conditions of alternating sea and shallow water and shore seem to have prevailed over the entire extent; for in Wisconsin, the surfaces of some of the beds are marked by tracks and trails as in New-York*. The fauna of the more westerly localities has afforded a few

* I have elsewhere shown the reasons for inferring that the beds with *Pentamerus oblongus* and *P. lævis*, in Great Britain, should be separated from the Caradoc sandstone; and I believe this view is generally admitted. As originally described, the Caradoc beds included species or their analogues which are, with us, unknown below the Clinton group; while the true Caradoc fauna corresponds to that of our Hudson-river group.

new species of fossils; and we may very justly conclude that between the Hudson and Mississippi rivers, in the parallel of New-York, no means exist for developing new conclusions of importance regarding this group of strata, which holds a very marked position between the true Lower Silurian and Upper Silurian strata, according to the divisions recognized in Great Britain*.

In tracing the Clinton group westerly, we find its affinities more with the rocks below, or that the material and fossils recognized on the one side as the Clinton formation are not strongly separated from the upper beds of the Hudson-river group; and studied in these localities alone, they might be regarded as constituting part of the same. On the other hand, the Niagara becomes defined as a calcareous group, and the line between it and the strata below is strongly drawn. The base of this limestone would everywhere be recognized as the base of the Upper Silurian rocks, while the strata below are marked by fossils which belong to the Lower Silurian fauna.

Much light has been thrown upon the history of these intermediate formations by the investigations before alluded to, in the island of Anticosti. It has been shown that the sediments of this period have been there deposited on a more extensive scale, and in a degree of completeness unknown elsewhere, while the fauna rises to the rank of that of the preceding or succeeding periods: therefore we are to look to developments in the northeast for an exposition of the facts and phenomena, which will establish the full value of this group in the sequence of formations and faunæ of the palæozoic times.

It is among the middle Silurian rocks of that region that we have more additions to our previous knowledge, than in any other among the older palæozoic formations. The very critical and elaborate investigations in the Geological Survey of Canada, carried on in localities, as we shall observe, nearer to the source of the sedimentary formations, and over a very wide area, promise results of the highest interest in investigations of strata which, to the west and southwest, gradually attenuate and finally disappear.

* See Palæontology of New-York, Vol. ii.

The Niagara group, which is the most important formation included in the second volume of the Palæontology, preserves, apparently, its most complete development in the State of New-York: there it consists of a calcareous shale and succeeding limestone, the former of which contains its most marked and peculiar fossils, particularly the Crinoidea, Brachiopoda, and Trilobites; while the limestone, often for miles in extent, bears the character of a coral reef, with few fossils except corals. In tracing this group eastward through New-York, we find it gradually diminishing in thickness, until, before reaching the Helderberg mountains, it is reduced to a band of limestone, sometimes brecciated, and often associated with a concretionary calcareous shale which is nearly or quite destitute of fossils. Its most easterly recognized extension is on the Hudson river, where it is very obscurely developed, and not everywhere continuous. In a southwest direction, along the Appalachian range, it is not conspicuous; and although I have traced it in its varying phases as far as Virginia, still in no locality examined has it attained any important thickness*.

In the northeast, while there are certain indications in the fauna of the existence of this group, it does not seem to have acquired a full development; for though a great abundance of fossils have been there obtained from the horizon of Niagara or the upper part of the Clinton group, there is a constant absence of certain forms which are peculiarly Niagarian, while many of the most predominant are such as occur in the limestones which in New-York we include in the upper part of the Clinton group, but which in some instances bear stronger relations to the Niagara than to the Clinton group in its lower members.

Probably no line of separation between our several formations requires so much careful examination and revision, as that between the Clinton and Niagara groups, when studied with a view to the true grouping of the fauna. The want of constancy in physical conditions during the period of the Clinton group, and particularly at the close of the epoch, induced the New-York geologists to include in that group all the variable formations

* Both the Niagara and the Lower Helderberg groups, as well as the Onondaga-salt group, are included by Prof. Rogers in No. VI of his Pennsylvania formations.

of that assemblage; and the original name proposed by them, of the "PROTEAN GROUP," well expresses its heterogeneous and varying character. Taking, therefore, for the base of the Niagara group a line which was found to be constant and could admit of no question, they have probably left out some beds which, with farther knowledge, might with equal or greater propriety be included in the Niagara group.

In the present state of our knowledge of these formations, and the known expansion of the lower one in the northeast, together with the fact that in this direction we are to look for the source of our sedimentary materials, we must regard the lower shaly member of the Niagara group as only a modification of the shale formations preceding it in the Clinton epoch. Moreover the Niagara shale, in its eastern extension, is less fossiliferous, and assimilates more in character to the shales in the Clinton group. These points of enquiry can only be determined by careful comparison of the different members as they occur in New-York and in the northeast; a work which is rendered difficult, by the wide hiatus existing in these formations between Central New-York and the nearest points at which they are known in Canada East.

Tracing the Niagara group from New-York westward, we find the shaly member gradually disappearing, and the entire group becomes calcareous. The limestone of this formation, which in Western New-York forms a bold escarpment known as the Mountain Ridge, maintains this character in Canada West, and its last locality is the promontory of Cabot's Head. Although broken and denuded in its extension across the northern part of Lake Huron, it is nevertheless clearly seen in the islands marking the great curve from Cabot's Head on Lake Huron to the promontory of Porte de Morts on Lake Michigan at the entrance of Green Bay. From the latter point, with some undulations and breaks in its outline, the bold escarpment is traced by the eastern shore of Green Bay to the head of those waters, and thence by the Fox river and Lake Winnebago to Milwaukie. In this vicinity and southward, it gradually disappears beneath accumulations of drift; but it is nevertheless traced in distant exposures

into Illinois, where it still retains the characters and the fossils which mark its occurrence in Wisconsin.

Throughout much of this extent, the limestone is not in a condition to preserve the smaller and more delicate fossils, and the larger corals are often the only conspicuous forms. The *Pentamerus oblongus*, which, within New-York, is confined to the calcareous beds of the Clinton group, is everywhere, in the west, a characteristic fossil of the Niagara limestone; and in Wisconsin and Illinois, it acquires a development in size and in numbers of individuals truly surprising. In many western localities the most conspicuous and prevailing fossils of the Niagara limestone are large cephalopods of the Genera *Orthoceras*, *Gomphoceras*, *Lituites*, etc.

In the neighborhood of Milwaukie and of Waukesha, the peculiarities in the development of the different members of this limestone group have induced Mr. I. A. LAPHAM to constitute a distinct member, the Waukesha limestone. From an examination of the localities, and a comparison of the fossils, I have not found sufficient evidence to warrant a separation from the Niagara group, and must regard the peculiar features as a phase of some portions of the Niagara limestone, and a condition not likely to be persistent.

The limestone of Waukesha consists of thin-bedded, fine-grained layers, which in the original condition must have been an impalpable calcareous mud, supporting during its deposition scarcely anything except a few orthoceratites and some other cephalopodous shells. In other localities the irregular heavier bedded porous limestone, with corals and other fossils, bears a more complete correspondence with the Niagara limestone as we know it in its eastern localities.

These varieties of the formation, being the result of varying conditions in the ocean of the Niagara period, have furnished some new forms of animal life; but the extent here traced from the western limits of New-York, around a great curve measuring twelve degrees of longitude, has produced altogether fewer species of fossils than the single locality of Lockport, or the banks of the Genesee river below Rochester; so that were

the examinations confined to this great extent of outcrop and exposure, the fauna would be regarded as very meagre indeed.

The line of escarpment extending from the promontory of Porte de Morts, by Green Bay, Lake Winnebago, and Lake Horicon, indicates the presence of lower formations; and it has been shown that a low axis extending from the northward has elevated the older rocks, while denudation has removed the higher beds over a wide area : and to this force of denudation we owe this long escarpment of the Niagara limestone. This is proved by the numerous outliers of the Niagara limestone between that escarpment and the Mississippi river; and finally before reaching the river in the northern part of Illinois, the limestone becomes again a continuous formation, with a trend northwest and southeast, and an escarpment facing to the northeast. From the Mississippi river this escarpment extends northwesterly through Iowa, till with greatly diminished thickness it passes into Minnesota.

I have heretofore shown the occurrence of this group in Northern Kentucky, where it is marked by characteristic fossils; and I have myself seen the limestone of this age, with numerous characteristic corals, near Cape Girardeau on the Mississippi river in the State of Missouri.

By reference to the map, it will be seen that the Niagara group has been traced from east to west, almost continuously, over an extent in a direct line of about twenty degrees, and along its line of outcrop at least a distance of five hundred miles more; while from its extreme known northerly limits to its most southerly known point of exposure, is more than twelve degrees of latitude.

It should not be forgotten, moreover, that many of the fossils enclosed in the drifted pebbles on the shores of Lake Superior are so nearly identical, and others identical with Niagara species, that we must infer the existence of an equivalent formation far to the northward, from which these drifted fossils have been derived. Over this area the condition of the ocean at that period was of a depth and temperature so nearly uniform, as to admit everywhere of the existence of corals of the same genera, and, to a great extent, of the same species.

In New-York, the upper part of the Niagara limestone is well determined by the sequence of the soft, marly, and shaly deposit of the Onondaga-salt group. In proceeding westward, however, the contrast in the succeeding formation is not so great; the beds are more calcareous, and finally become fossiliferous, so that we must either admit an intermediate member of the series, or recognize the lower member of the Onondaga-salt group to be fossiliferous. In the present state of our knowledge, this horizon is one promising interesting results to investigation.

In the second volume of the Palæontology of New-York, I have given some fossils from Canada West, as coming from the Onondaga-salt group. These were of species not recognized in the Niagara group, and some of them of genera unknown in that period. Moreover, some of them were similar to a few forms obtained in New-York, from excavations made at the base of the Onondaga-salt group; and consequently I inferred these to be of the same age. A farther examination of the fossils themselves induced some doubts regarding the propriety of this reference; and my examinations in the west have rendered it quite certain that there is intercalated between the Niagara and the Onondaga-salt group a distinct set of strata, marked by a fauna which, partaking in part of the character of the Niagara, is yet quite distinct. At some points on the northern shore of Lake Michigan and elsewhere in the lake region, there occurs a light-colored limestone lying above the Niagara strata, containing generally few fossils, and among them some forms not unlike those of Galt in Canada West.

In Iowa, at the Rapids of Le Claire, and extending northwesterly into the State, we find resting upon well determined Niagara limestone a light, gray, porous limestone, with numerous casts of fossils, all of which are unlike those of the Niagara group, and of species so peculiar as to render it necessary to refer the rock and its fauna to an epoch distinct from the Niagara period.

Although the facts yet collected have not that perfect connection which we could desire, there is still sufficient known to warrant

the belief that there exists a continuous group of strata, marking a stage in the Palæozoic period above the Niagara group, and perhaps in some places not sharply separated from it, but which will exhibit a distinctive fauna. The determination of this question must be made by examinations through Canada West and the Western States, since the formation would appear to lie conformably over the Niagara group, and to follow the same trend to the westward. The strata holding this position in Canada have been shown by ALEXANDER MURRAY, Esq., of the Canadian Survey, in a letter to Sir WILLIAM LOGAN, to hold a defined position above the Niagara group*.

The Onondaga-salt group, with its gypsum beds, has heretofore been described as it occurs in the State of New-York. It is likewise known to extend through the peninsula of Canada West, and forms a part of the island of Mackinac; while the pebbles of porous limestone forming the beaches on all the islands of this region, show how extensive has been the destruction of this group of strata. Westward from Mackinac these rocks have not been recognized as far as the peninsula, nor in the peninsula of Green Bay; and I have shown how, from their destruction, have resulted portions of Lake Huron and Lake Michigan†. It is only near Milwaukie that some beds have been discovered, by Mr. LAPHAM,

* "With regard to the age of the group of rocks which appear at Galt, and which Mr. HALL proposes to class as a part of the Gypsiferous instead of the Niagara formation, this season's examination has tended to show that his suggestion is founded upon correct data.

"The rocks in question are extensively displayed on the Grand river, from Middleton bridge on No. 21, 6th Concession of Dumfries, all the way to the forks of the Speed above Preston; at Guelph, upon the Speed; between Elora and Fergus on the Grand river; and on the banks of the Rocky Sauquin. The fossil Mr. HALL proposes to call *Megalomus canadensis* was found in all these localities, but most numerous at Galt and at Elora, and in all cases only among the upper beds of a group of limestone strata of peculiar character. Numerous spiral shells, among which we supposed we could recognize the *Loxonema boydii* and *Euomphalus sulcatus*, and numerous corals, were found associated with the *M. canadensis*, and also in most of the lower beds of the group, especially at Elora, where there is a vertical section of the group exhibiting about 80 feet. There is an undoubted difference in mineral as well as fossil character, between these limestones and others on which they repose. The inferior rock is a dark brown and sometimes almost black, very bituminous limestone interstratified with black bituminous shales; whereas the upper one is of a pale yellowish or drab color, sometimes granular in structure and apparently entirely free from bituminous matter. The transition from the lower to the higher rock is well developed at Guelph on the river Speed."

† JAMES HALL, in Foster and Whitney's Report.

which bear the character and hold the position of the Onondaga-salt group.

During the explorations carried on in Iowa in 1855, we discovered along the Mississippi river, at Le Claire and above, beds of drab limestone having the chemical composition, lithological aspect, and position of the higher beds of the Onondaga-salt group; while the thin-bedded lower portions present numerous small arched cavities, precisely of the character of those which in New-York contain the gypsum beds. In tracing these into the interior, they soon become lost beneath the accumulated drift. From all these circumstances it is apparent that this formation has once extended over the intervening space, and that its continuity is broken only by the extensive denudation which has swept over the entire lake country with such resistless force.

In the next superior strata, the Waterlime group of New-York, we find the horizon in this country of those peculiar crustaceans, the *Eurypterus* and *Pterygotus*, which will be described and illustrated in this volume.

The relations of strata bearing similar organisms in Great Britain has lately been discussed by Sir RODERICK MURCHISON*, and they acquire an importance from being regarded as the uppermost beds of Silurian age in that country.

Limiting our comparison to Western New-York, and the continuation of the same beds westward, this view of the sequence would be entirely applicable; for we find the Waterlime group succeeded everywhere by strata bearing ichthyic remains. When we turn to Eastern New-York, however, we find the Eurypterus beds succeeded by a fossiliferous formation, which is intercalated between them and the strata bearing the earliest known evidences of the existence of fishes. Here the Lower Helderberg limestones, not known at the west, rest upon the Waterlime group, and to that group succeeds the Oriskany sandstone; all these preceding the fish-bearing strata.

* MURCHISON's "Lesmahago Silurians:" Quart. Jour. of the Geol. Soc. London, Vol. xii, p. 15 *et passim*. 1856.

The Lower Helderberg group, which constitutes the more important portion of the strata from which are derived the fossils of the present volume, has been so termed from its very complete development along the base of the Helderberg mountains; constituting, in this part of New-York, an important fossiliferous group. In some parts of the Helderberg mountains, and along the Hudson river at Rondout, and at Schoharie and elsewhere, the lowermost beds of this group rest directly upon the Waterlime beds, which we regard as the uppermost member of the Onondaga-salt group, indicated as a separate formation by reason of its economical importance, and likewise characterised by certain peculiar fossils, while the marls of the Salt group are usually nonfossiliferous.

The lowest member of the Lower Helderberg series is a thin-bedded, often thinly laminated, dark-blue limestone, which, from the abundance of its tentaculites, has been termed the Tentaculite limestone. Its color, texture and composition, contrasts strongly with the rock below.

The second member of this group is a thin mass of limestone, consisting almost entirely of the coral *Stomatopora*, and constitutes a very persistent member of the group; to this succeeds a limestone charged with great numbers of the broken shells of *Pentamerus galeatus*, and known as the Pentamerus limestone. This graduates above into a shaly formation, which was designated in the New-York Reports as the Delthyris shaly limestone, from the abundance of this genus of fossils. It is the most fossiliferous member of the group, as will be seen by consulting the position of the fossils described in the following pages. This shaly limestone, in physical character and composition, corresponds nearly with the shaly member of the Niagara group, and contains numerous similar or representative forms.

To this succeeds a compact crinoidal limestone, and above this is a mass of bluish gray limestone, charged with Brachiopoda, among which a *Pentamerus* similar to *P. galeatus* is so abundant that the rock has been termed Upper Pentamerus limestone.

A comparison of the species shows that the fossils of the Lower Helderberg rocks are analogous to those of the Niagara group, and contain among them certain species which we regard as representative forms of the Silurian species in Europe; and we cannot do otherwise than retain this series as a member of the Silurian system.

It would seem, therefore, a very natural inference, since the presence of the Genus EURYPTERUS is regarded as marking the uppermost strata of the Silurian system of Great Britain, that our Lower Helderberg group constitutes a series of strata not recognized, and probably not existing in the British islands.

The sequence of these groups, as occurring in the eastern and western parts of New-York, and their equivalents in Great Britain, is as follows in the descending order:

Eastern New-York.	*Western New-York.*	*Great Britain.*
UPPER HELDERBERG GROUP,	UPPER HELDERBERG GROUP	= Devonian or Old Red sandstone, with fish remains.
ORISKANY SANDSTONE, LOWER HELDERBERG GROUP.	Not occurring in Western New-York.	
WATERLIME GROUP,	WATERLIME GROUP,	= Horizon of Lesmahago, with *Eurypterus*.
ONONDAGA-SALT GROUP,	ONONDAGA-SALT GROUP.	
NIAGARA GROUP,	NIAGARA GROUP,	= Wenlock limestone.

The relations of these crustacean beds to the earliest Ichthyolite beds in Great Britain is very clearly shown by Sir RODERIC MURCHISON, with the important conclusions derived therefrom. But while there the conditions of the ocean apparently admitted of the direct succession of the two faunæ, we have in the United States a very strongly marked line, which has been traced over more than fifteen hundred miles of outcrop, with no mingling of material or of the faunæ.*

It is interesting to observe these points of difference in the conditions of the two continents, at the time of the distribution and deposition of these sediments and the accumulation of calcareous material. These discrepancies are moreover suggestive of enquiries as to how far the

* Notwithstanding this evidence of separation over so wide an area, I am still disposed to believe that we may find localities which, from the accumulation of material having been uninterrupted, will show a gradual passage from one to the other of these formations, if not a mingling of the two faunæ.

deposits may have been synchronous; or whether indeed farther investigation along the line of the junction of these formations may not disclose new relations; for though the great mass of a recognized group of strata will furnish the prominent data for the more comprehensive conclusions, it is only by a careful search along the line of junction of the successive groups that we become acquainted with those conditions of change which ushered in the new era. It is by these investigations that we acquire numerous facts of apparently minor importance in themselves, but which lie at the foundation of all our conclusions regarding the true relations of the successive parts in the great geological sequence.

The most striking contrast between the fauna of the Lower and Upper Helderberg groups is in the abundance of large corals and the remains of fishes in the latter, while in the former we find few large corals and no remains of fishes. And although in the general expression of the brachiopoda of the two periods there may be no very marked differences, yet the evident relations of the Lower Helderberg fauna to the Niagara fauna will be seen at every step of comparison, and shown in the illustrations and descriptions in the following pages. If therefore similarity of physical conditions and similarity of fauna are to govern us in determining the relations of formations, then the Lower Helderberg group should be united with the Niagara group in one great system.

In regard to these questions, however, I have long since expressed the opinion, founded upon extensive observation in the United States, that the lines of demarcation between subordinate groups, and the line of separation between systems are equally strong, and that the whole series may be regarded as a succession of minor groups; that the strong lines of division are almost always due to the absence of some formation, which if present would show a gradation to the next; and these subdivisions into systems have been made dependent on the imperfection rather than the perfection of the sequence.

Thus the strong line of demarcation between the Silurian and Devonian which exists where the Lower Helderberg group is absent, is softened to a gentle gradation through the intervention of these strata and the Oriskany sandstone. Where these are present in all their members the line of separation becomes less sharply defined, and we have some evidence that there may exist other intermediate members, or a more full development of those now known between the two formations.

However true therefore it may be that both in Great Britain and in parts of this country the Eurypterus beds represent the Upper Silurian horizon, we must carry the line of that horizon upwards and include in the Silurian series the fauna of the Lower Helderberg period. At the same time we are ready to admit that there are many points of argument for classing the Oriskany sandstone as an intermediate formation, terminating the Silurian and forming the base of the Devonian system, as now most generally recognized in Europe. In this view of the subject, the evidence of the relations of these faunæ will be given in the following pages and illustrations.

Having now carried on our observations through the successive formations as far as the line where vertebrate remains are known to appear, and which has generally been acknowledged as the commencement of the Devonian system, we may review the same in their physical conditions, and the circumstances attending their distribution.

In the earlier groups of strata, and more particularly in those which are highly calcareous in composition, we find the trend of the outcrop to have a generally east and west direction, following the northerly curve which has been described. Thus in all the lower Silurian limestones we trace the outcrop to the west and northwest, from the base of the Appalachians in New-York or in Canada, to the Mississippi river, and thence still in the same northwesterly direction.

The Hudson-river group, in its finer sedimentary portions and in its calcareous shales, trends away to the northwest beyond the Mississippi river. The same is true of the Clinton group, though this is scarcely

recognized in its marked characteristics far to the westward. The Niagara group, in its pre-eminently distinctive features, has been shown to follow this great northwestern curve, and to stretch far beyond the Mississippi river. The Onondaga-salt group follows a parallel line of outcrop, and is traced into Iowa in thin strata; its continuity, interrupted in some slight measure by the axis which occurs in Wisconsin, can be followed over this great extent of country, and still to the westward.

In the Lower Helderberg group, however, the line of outcrop and of principal accumulation has been from northeast to southwest. A great change in the condition of the ancient ocean did supervene after the deposition of the strata charged with the peculiar crustaceans already noticed. Instead of finding the outcrops of the Lower Helderberg strata in lines parallel with those of the preceding rocks, the relative direction of the main accumulation and the principal line of exposures is diagonally across the others.

The investigations of the Canadian Geological Survey have shown the occurrence of these rocks in great force far to the northeast, in Gaspe on the Gulf of St. Lawrence, and the strata are traced thence southwesterly: they are seen near Montreal, lying unconformably upon the Utica slate.

In New-York the strata of the Lower Helderberg group are exposed on both sides of the Hudson river. Upon the east they form an outlier known as Becraft's mountain, and on the west they are seen in the Helderberg mountains, where, in the absence of the intermediate formation, they often succeed the Hudson-river shales, or, in other places, with the intervention of a few feet of other rocks. Westward we find these strata gradually thinning out, and we have scarcely any evidence of their existence in New-York west of Oneida county. On the other hand, when we follow the same beds in a southwesterly direction from the Helderberg mountains through Pennsylvania, Maryland, Virginia, and Tennessee, we everywhere find the same group of strata, and bearing everywhere more or less the same species of fossils, with constant accession of new forms. In some localities in the middle

and southern parts of Tennessee, the collections of fossils are so like those from the Helderberg mountains, near Albany, that but for their color and here and there a difference in the development of certain forms, there would be little to distinguish the two localities.

During the period of the deposition of the Upper Helderberg limestone, the area of accumulation corresponded to the direction of the ancient currents and spread far westward, as at the period of the deposition of the Hudson-river group; but during the accumulation of the Lower Helderberg formation, the condition of the ocean on the west was such that no deposits were made, and, so far as we know, no fauna existed over a very large area. At the same time, along the line of the Lower Helderberg group, marine life was more prolific than at almost any previous period. We already know nearly three hundred species from this group; and this number does not include some forms known in Gaspe, and others which occur in greater numbers in Tennessee.

Whether on the west there existed a deep or a shallow sea, or what the conditions were, we have no means of knowing; for the entire interval between Central New-York and the Mississippi river, and from the northern limits of the Silurian strata on the great lakes to the mouth of the Ohio, afford no evidence of a fauna of the age of the Lower Helderberg group.

Nor is this absence due to subsequent denudation, for we are able clearly to trace the thinning out of the beds as well as the lines of the greatest accumulation and greatest vitality; and these lines are apparently correspondent and co-extensive.

Influenced by considerations of the physical conditions alone, we would naturally incline to make the base of the Lower Helderberg group a line of separation between the geological systems. Great physical changes had taken place; the relative positions of sea and land, or at least the relations of the previously formed deposits to the sources of these deposits, had been materially changed. The older sediments had become in some degree consolidated, and had likewise suffered

folding and distortion. A line of ocean bed, at least for two or three hundred miles, and probably much more, which had not been reached by the sediments of the Niagara and Onondaga-salt periods, presented a set of strata more or less inclined, upon which the calcareous sediments of the Lower Helderberg group were deposited*.

Parallel to and near the line of the strongest current of the preceding period, the ocean had now become quiescent; and instead of the transportation of coarse sediments, which had spread out the conglomerates of the Shawangunk mountains and the Blue ridge, we have in the Lower Helderberg group evidences, along the same line, of quiet waters depositing calcareous mud, and marked near its beginning by a broad belt or reef of slow-growing corals, and in its central portions by the finer argillaceous mud which supported myriads of brachiopoda and of fragile gasteropoda, showing the most quiescent condition for a long period of time.

This epoch of calcareous accumulation was followed by an almost purely arenaceous deposit, which, mingling with the later sediments of the preceding formation, produced, near the junction of the two, a calcareous sandstone of a peculiar character which we find in the Oriskany sandstone. This formation, known as far to the northeast as the region of Gaspe, stretches to the southwest almost coincident to the line of the Lower Helderberg rocks; spreading continuously very little

*I have, on a former occasion, expressed some doubt regarding the asserted nonconformity of the Lower Helderberg rocks to those below. In Becraft's mountain, on the east side of the Hudson river, the strata of this age lie inclined above the Hudson-river group, and their appears no positive evidence of their unconformability. On the west side of the Hudson river, the highly inclined strata of the Hudson-river group are succeeded by the Lower Helderberg rocks at a very different inclination; and there are some thin intermediate inconspicuous layers, which, from the presence of some obscure corals, may be referred to the age of the Coralline limestone or to the Niagara group. Farther west, within fifteen miles of the Hudson river, and extending many miles westward, the Lower Helderberg strata lie above the Hudson-river rocks, as seen in the northern escarpment of the Helderberg mountains, and the inclination is entirely conformable. Finally, the thinning eastern edge of the Onondaga-salt group comes in between the two formations; and still farther west, the Niagara and Clinton groups intervene before the disappearance of the Lower Helderberg by thinning to the westward.

to the westward*, but extending with great force through New-York, Pennsylvania, Maryland and Virginia.

This sandstone is charged with great numbers of peculiar fossils: Brachiopoda of larger size than those of the preceding strata occur in immense numbers, so that the rock is often a complete mass of these shells. In some places, Gasteropoda of the Genus *Platyceras* occur in such numbers, and in such positions, that they could only have been so placed from being drifted together by gentle currents; for these shells, thin and fragile like the modern *Janthina* (to which family they belong), are preserved in great numbers in what are termed "pockets," packed together in loose sand, which, in some places in Maryland and Virginia, is no more coherent than the sands of a modern sea-beach. These gasteropods, moreover, assume so great a variety of form and modification of parts, that it often becomes extremely difficult to distinguish specific differences or generic relations.

We have at this period a profusion of individuals, represented by few species of this class of animals, to which we have no parallel in any of the palæozoic groups; while the preceding and following formations nearly equal this in the abundance of individuals, and present a larger number of species.

Certain brachiopods, not known till the period of the Lower Helderberg group, acquire, in the Oriskany sandstone, a development truly astonishing; and two genera, at least, attain at this time their acme, and in the next period gradually decline. In the Oriskany sandstone we meet, for the first time, so far as would appear from our New-York formations, *Spirifers* with bifurcating costæ; a character ever afterwards exhibited in some species of each succeeding period, and peculiarly marked in those of the Carboniferous limestones and Coal measures.

M. DE VERNEUIL, and other European geologists, have been inclined to place the dawn of the Devonian period in the horizon of the Oriskany sandstone, and to regard this and the succeeding rocks as separable

* The Oriskany sandstone continues westward, with some slight interruptions, to Cayuga lake; beyond which, it has been found only in isolated patches.

from those below on certain palæontological grounds; giving, among other evidences, the occurrence of *Spirifers* with dichotomizing ribs*.

In this place, before proceeding to the consideration of the higher groups, it may be useful to present some facts relative to the supposed equivalency of certain formations, and their relation to the lines of subdivision between great systems.

It is acknowledged that we have very satisfactory evidence of the parallelism of the Niagara group with the Wenlock formation of England, from similarity of position, analogy, and, to some extent, identity in fossil remains. We have seen that this group, together with the Onondaga-salt group, were deposited in an ocean which had suffered little change in its bed, or in the direction of its accumulations, from the period of the Trenton limestone : the general trend of the formation and the line of accumulation have been similar. At the close of the latter epoch, there lived those peculiar crustaceans which are supposed by Sir RODERICK MURCHISON to mark everywhere in the northern hemisphere a corresponding zone. Thus far we are able to find a pretty satisfactory parallelism with European formations; and thus far the depositions have gone on in the same general direction, and have been spread over the bottom of the same pre-continental ocean.

We see, at the commencement of the Lower Helderberg group, that there are evidences of great physical changes in the bed of the ocean; so that the sediments of this epoch were confined to a narrower limit than the preceding group, and do not reach westward over the same area, but trend in a northeast and southwest direction. This condition continued through the period of the Oriskany sandstone, which followed with comparative quiet the previous area of deposition, and in some places forms with it almost a natural group of strata.

Notwithstanding, however, the great physical change which preceded the Lower Helderberg deposits, the materials are in character not

* In the west, there is a *Spirifer* with dichotomizing ribs in strata of about the age of the Niagara group.

unlike to those of the Niagara group, and the fauna presents comparatively little contrast. The same genera, and very similar species of Corals and Bryozoa occur in both groups. Among the Brachiopoda, the *Orthides* of the two groups have so much resemblance that they have been confounded one with the other. The *Strophomenæ* are of the same character, but we have other and more numerous forms in the Lower Helderberg group. The *Spiriferæ* of the Niagara and of the Lower Helderberg formations are not readily distinguishable in several species, and the *Rhynchonellæ* and *Meristæ* equally resemble each other, and are only more numerous in the later period; while we have superadded the Genus PENTAMERUS in *P. galeatus* and another similar form, and also two or three genera of Brachiopoda which I have not seen in a lower position. Thus in many aspects we might almost regard the Lower Helderberg as a repetition of the Niagara strata.

It is not, therefore, between these groups that we can draw the line of demarcation for the Silurian and Devonian systems. Shall the advent of the Oriskany sandstone, with its *Spirifer* of dichotomizing costæ, be the division? Or shall we look for some more marked and more readily defined and recognized feature for the distinction between what are regarded as two great geological systems?

Thus far in our progress we have not recognized among our fossils evidences of one great class of animals, the VERTEBRATA, which is represented for the first time, so far as we yet know, in the Upper Helderberg group, or, doubtfully, in the upper members of the Oriskany sandstone*.

We find also that a great physical change has preceded the Upper Helderberg deposits; an oscillation or sinking of a zone of the ocean bed, by which the sediments of this period were allowed to spread over the great western area, equally with those which preceded the Lower Helderberg period. Thus we have a great but quiet physical change,

* A single fragment of a fossil, which was referred to an Ichthyolite, is known in the Oriskany sandstone. The so-called *fish-spines*, in the Niagara group (Vol. ii, Pal. N.Y.), are spines of crustaceans of the Genus *Ceratiocaris*.

affecting the conditions of a vast area, and with a corresponding change in the fauna; and if we regard this evidence as sufficient for the dawn of a new period, we would limit the commencement of the Devonian to this horizon.

The Upper Helderberg group, in its fullest development, consists of four members, the Cauda-galli grit, the Schoharie grit, the Onondaga and Corniferous limestones. The first, when characteristic, is a dark, gritty slate, which, even in its unaltered condition, has a cleavage vertical to the line of deposition, and is generally destitute of fossils; but with surfaces covered with curved, fucoid-like markings which have given it its name. This rock constitutes beds of passage from the Oriskany sandstone, and graduates above into the Schoharie grit, which is an arenaceous limestone, weathering to a brownish color, and succeeded by the gray subcrystalline coralline formation which is known in New-York as the Onondaga limestone, while the Corniferous limestone consists of the higher dark-colored cherty beds of the group.

In tracing this formation westward through New-York, the lower members gradually thin out, and neither the Cauda-galli nor the Schoharie grit are known so far west as the centre of the State. It is in the Schoharie grit in the eastern counties of New-York, Albany, Greene, and Schoharie, that we first find those bony plates belonging to the early fishes. These plates or scales, with some fragments of bones, are all that we yet know of the occurrence of that class of animals in this period of our geological history. In the succeeding limestones at the west, there is an increasing number and variety of these ichthyolites.

This limestone formation is of great extent. Tracing it through New-York and Canada West, we find it reappearing in Michigan, extending to the northern extremity of the southern peninsula, and forming the summit of Mackinac island; thence trending southward, it appears in Indiana and Illinois, and is traced into Iowa, where it is almost non-fossiliferous. Corresponding to the general contour of the country, this limestone lies on the two sides of the low Cincinnati axis. On the eastern side, it appears in Sandusky, Ohio, and thence is traced south-

westerly through that State into Kentucky and Tennessee. On the western side, it extends through Indiana to the Falls of the Ohio, and thence through Kentucky and Tennessee, where the declining elevation of the axis permits the two outcrops to unite. The same group, in one or more of its members, has been recognized in Missouri*, and it is probably co-extensive with the subcarboniferous formations of the west.

This group therefore is very widely spread over the United States, resuming the same area, and being, so far as we know, co-extensive with the Niagara group; which preceded the physical changes that for a time modified the area of deposition, and restricted to a more easterly zone the sediments and calcareous accumulations of the intermediate groups.

With the limestones of this period, we recognize the beginning of the true Ichthyic fauna, which was first indicated in the Schoharie grit. The fossils of this period, though not yet known to be so abundant or so remarkable as those of the same period in Europe, nevertheless correspond in character with those of the Old Red sandstone of England and Scotland.

With the advent of the fishes at this period, we find that there is a remarkable accession of corals, and the variety of form and the number and size of species is much greater than at any preceding period. We may follow the outcrop of this formation, bearing in many places the aspect of a coral reef, along a line of more than fifteen hundred miles from its eastern† to its most southwesterly extremity; and returning northward on the other side of the axis, trace it for nearly a thousand miles from Tennessee to Mackinac; extending thus from latitude 46 on the north to latitude 33 on the south, and occupying, in its greatest width, twelve or fifteen degrees of longitude. When we reflect that this has probably at one time been an unbroken expanse of

* Report of Prof. SWALLOW.

† In estimating the extent eastward, I do not include the evidences of limestone of this age in the Green-mountain range in Canada, as shown by Sir WILLIAM LOGAN, nor similar evidences in the Connecticut-river valley in the north part of Massachusetts.

coralline limestone, covering the greater part of this area, we may form some conception of the immense extent of that ancient ocean, whose quiet waters admitted of such a vast area of undisturbed coral reefs.

Succeeding the Upper Helderberg group, we have to contemplate a renewal of conditions almost precisely similar to those which followed the epoch of the Trenton limestone. In that earlier period, the fine sediments of the Utica slate, and the green shales of Frankfort in New-York, were followed by alternations of fine and coarse material, constituting the Hudson-river group. At this latter epoch, succeeding the upper members of the Upper Helderberg group, we have a black, fine-grained shale, with some bands of limestone; again followed by a soft bluish calcareous shale, above which are alternations of argillo-calcareous and shaly arenaceous bands, the mass varying in composition at different localities, and terminating above in more arenaceous deposits. These constitute the Hamilton group with Marcellus shale at base, the Portage group, and the Chemung group.

In like manner we find the source and origin of these strata to correspond precisely to that of the Hudson-river group; and we see repeated, after this long interval, all the phenomena which accompanied the Lower Silurian formation.

The greatest accumulations of material in the period of the Hamilton, Portage, and Chemung groups, lie in the direction of the Appalachian chain. In Gaspe, we have the authority of Sir WILLIAM LOGAN for saying that there are seven thousand feet of strata, which must be referred to a period intermediate between the limestones and the Coal measures. In Pennsylvania, Prof. ROGERS has computed, in the corresponding Formations VIII and IX, eleven thousand feet of thickness*; while in Western New-York the Hamilton group alone is less than one thousand, and, including the Portage and Chemung groups, the whole together would scarcely exceed three thousand feet. We have, therefore, the clearest evidence that the strata thin out in a westerly direction.

* In No. IX is included a part of our Catskill-mountain series, so that a portion of this thickness is to be taken from the estimate of the Hamilton and Chemung groups.

But, to consider for the present the Hamilton group alone, we find it in Eastern New-York to consist, at base, of the black Marcellus shale already mentioned, including some bands of Goniatite limestone. Next succeeds a hard, compact, calcareo-arenaceous shale, which, under atmospheric influences, crumbles into angular fragments. This is followed by more arenaceous bands, and by bands of soft slaty shale, with arenaceous shale or argillaceous sandstone, and with some thin bands of limestone, which are almost entirely composed of organic remains. Towards the western part of New-York the coarser materials gradually diminish, and we find an increasing proportion of soft shales, with a more general diffusion of the calcareous matter, and the mass is terminated by a limestone. Finally, from the Genesee river to the western limits of the State, the entire group, above the Marcellus shale, which is persistent, consists of dark soft shales and bands of limestones. Thus the lithological characters are, at the east, an olive shale and sandstone; at the west, a grayish blue calcareous shale, with bands of limestone.

The contrast in fossil characters is equally strong. The great abundance of the lamellibranchiate fossils, so characteristic of the group in the eastern part of the State, gradually give place to a greater proportion of Brachiopoda as we progress westward. The prevailing forms of the east are aviculoid shells, with *Modiolopsis*, *Nucula*, etc., while brachiopods are few; while in the west the Brachiopoda predominate over every thing else.

So different are the characters of this group in the eastern and the western parts of the State, that were not the connection or absolute sequence of the formation traceable throughout, doubts might arise in regard to the identity of geological age.

When we follow the Hamilton group in a westerly direction from New-York we find it in Canada West consisting of materials rather more calcareous in character, and with thickness much diminished. The same condition is true of the group in Ohio, where, to the east and south of Sandusky, and elsewhere, it is seen with the underlying black

shale succeeding the Upper Helderberg limestones. On the western side of the Cincinnati axis in Indiana, we know of the existence of this group, from the fossils which have come to hand from different localities, and the succession of beds corresponds to the same in New-York. At the Falls of the Ohio, we find the Marcellus shale with some succeeding calcareous bands, which are followed by greenish gray and olive shales and sandstones. In Illinois and in Iowa the group consists of a bluish gray calcareous shale, which is much more compact than in New-York; and is succeeded by beds of limestone which in some places are of sufficient thickness to furnish quarries for building stone.

The entire thickness in any of the exposures is not more than sixty feet, and though the mass is often crowded with fossils, the number of species is of course less than in the eastern localities of the group. In Missouri, Prof. SWALLOW estimates the thickness of the Hamilton group to be fifty feet. We thus see that from a mass of much more than one thousand feet in Eastern New-York, this group thins to one of fifty or sixty feet in its western extension.

In studying this group on the western side of the Cincinnati axis, we find there precisely the same sequence as in New-York; and we are able to carry on continuous observations of some of the lower groups, both to the north and south, where the rocks are continuous. Together with the same sequence in Illinois and Iowa, we have numerous identical fossils, and among them *Strophodonta demissa*, *Atrypa reticularis*, *A. aspera*, an ORTHIS similar to *O. tulliensis*, *Spirifer fimbriata*, and other spirifers very similar to those of the Hamilton group in New-York.

The Marcellus shale, as it is seen in New-York, is marked by bands of limestone containing abundance of large Goniatites; and in nearly the same horizon in Indiana we find a belt of shale containing great numbers of Goniatites, and some other fossils not unlike those in the same association in New-York. There can, therefore, be no doubt whatever as to the true relations of the thin group of calcareous shales and limestones which we know in the Mississippi valley at Rock island,

Davenport, New-Buffalo, etc., as well as at Iowa city, Cedar rapids, Lime creek, Independence and elsewhere in the interior of Iowa.

And not only do we have the same sequence from below, but in ascending from the Hamilton group, we find a series of green shales and gray and yellow sandstones, representing the Portage and Chemung groups of New-York.

Turning again to the eastward for comparisons, of this sequence, we find in the eastern part of the State of New-York, where the Hamilton and Chemung groups become defined, that they have an aggregate thickness of at least three thousand feet, and probably, in some places, much more. We trace the succession where the greenish olive shales and sandstones of the higher series are separated from the Hamilton group by the Genesee slate; and following this line through Pennsylvania, and to the southwest from Cleveland in Ohio, we find the same sequence extending to the Ohio river near Portsmouth. Nor do we anywhere find evidences of the intercalation of another group of strata.

Again, on the western side of the Cincinnati axis, we take up the same sequence; and from Michigan on the north we trace it to the Ohio river, near New-Albany. We may recognize the same sequence in crossing the States of Indiana and Illinois, to the Mississippi river; and at numerous localities in the Mississippi valley we find the same series of strata.

In all the localities where I have been able to examine this series, the entire thickness, including some beds of Oolitic limestone at the summit, is less than two hundred feet. Prof. SWALLOW finds the same series in Missouri to be somewhat more*. The entire thickness, therefore, of this group of strata on the northwestern outcrop is generally not more than one-fifteenth of the same in Eastern and Central New-York.

* Including the fifty-five feet of lithographic limestone, which seems to me to have more intimate relations with the Hamilton group. The thickness of the Chemung group is about two hundred feet; and including the Hamilton group, the entire thickness is about two hundred and fifty feet.

On a careful comparison between the Chemung fossils of New-York and those of the Mississippi valley, we find scarcely a single species that can be considered positively identical. Many of the species are representative forms, and so closely allied to those of New-York, that heretofore I had regarded them as the same; and every one acquainted with the eastern species must perceive the close similarity, not only in the general features of each one, but in the grouping of the species together in the beds.

These examinations in the west have furnished some important terms in our problem, not only for comparison with the physical conditions prevailing and the direction of the distribution of sediments, but likewise in reference to the fauna and its persistence over wide areas. It is unfortunate that our comparisons of the faunæ of the east and west must end here; for there are no other formations in the palæozoic sequence, below the Coal measures, that afford an opportunity for comparison over so great an area as from the Hudson to the Mississippi river.

In considering the distribution of the masses of the formations which we have here described, we find that the greatest accumulations have been along the direction of the Appalachian chain. The original current, transporting the material, has been in the same direction, and consequently a greater deposition of the coarser sediment has marked the lines of the transporting force, which, necessarily diminishing on either side of the centre of this great current, the fine calcareous mud would be gradually conveyed to greater distances and slowly deposited. The material thus transported would be distributed, precisely as in an ocean traversed by a current, like our present Gulf stream; and in the gradual motion of the waters during that period, to the west and southwest, the finer materials would be spread out in gradually diminishing quantities, till, finally, the deposit from that source must cease altogether.

We see this illustrated in the minor members of a group; and the same must be true in the larger ones, and of the whole together, since

the greater masses are made up of the smaller. At the same time we have a partial or entire disappearance of the fauna of a period just in the same ratio of the diminution of the sediments; unless the conditions of life may have been more favorable in some localities.

We may not forget, also, that in many localities the accumulation of the mass of fifty or one hundred feet, has occupied the same length of time as the mass of one thousand or of five thousand feet; for the thinning areas of formations show no indication of cessation of deposition during any period from their commencement, and we have no evidence that they have not begun and ended as have the entire group in its greater accumulation.

I have long since shown, from observations in New-York and New-England, that the portion of the Appalachians known as the Green-mountain range is composed of altered sediments of Silurian age; and the same has been shown by Prof. ROGERS to be true of much of the metamorphic part of the range in Pennsylvania. The evidences in regard to the White mountains, though not quite so satisfactory, left no alternative but to regard them as consisting of strata, which, to a great extent, are of newer age than those of the Green mountains, or Devonian and Carboniferous, though fundamentally, perhaps, resting on beds of the same age. The statements of Sir WILLIAM LOGAN, in regard to the great accumulation of strata in the peninsula of Gaspe, together with the observations of Prof. ROGERS in the Appalachians of Pennsylvania, lead to the inevitable conclusion that the sediments of this age must everywhere contribute largely to the matter forming the metamorphic portion of the Appalachian chain, as well as to the non-metamorphic zone immediately on the west of it. We may then regard it as established that the White mountains owe the great proportion of their mass to sediments of the age of those strata which we have just described, while those of a later period may constitute some considerable portion of the range.

From the facts here stated, the student is prepared to appreciate the conclusion, that all the sedimentary formations above the Trenton

limestone have had a line of greater accumulation; and that it is demonstrable, from the combined investigations of geologists, that this line was along the course of the Appalachian range. In the second place, all the observations carried on through New-York, Ohio, Indiana, Michigan, Wisconsin, Illinois, Iowa, and Missouri, show a thinning of these sediments in a westerly direction, until, in the Mississippi valley, they have greatly attenuated or entirely disappeared.

Following the Chemung group, we have in New-York the shales and sandstones of the Catskill mountains, forming in their greatest expansion a mass of at least three thousand feet in thickness. To the northeast this formation has not been recognized as a distinct group, though we infer that it may be included in the great mass constituting the section of seven thousand feet of strata shown by Sir WILLIAM LOGAN to exist between the limestones below and the Coal measures above*.

In New-York this group has its greatest expansion just to the west of the metamorphic belt, on the west side of the Hudson river; raising its summit (including the conglomerate) in the Catskill mountains to the height of 3800 feet above tide water. The group is composed of red and greenish or olive shales, and shaly sandstones, with some gray and mottled sandstones and conglomerates, the latter forming heavy masses at the summit of the formation.

This group presents a very interesting topographical feature, and one of even greater interest in the dynamics of geology; for we have here mountains of nearly horizontal sedimentary and almost entirely unaltered strata, consisting mostly of a single group, attaining an elevation rivalling that of the disturbed metamorphic belt upon the east, where the highest points are rarely more than four thousand feet above the level of the sea.

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* It seems to me not improbable that the earlier appearance of terrestrial vegetation in the northeast, or at least the greater amount of such vegetation, during the earlier part of the Devonian period, may have resulted from, or have been accompanied by, conditions so different from those then existing farther to the west and southwest, that the lines of demarcation between groups may not always correspond.

We are yet unprepared to speak with the same degree of certainty regarding the source or direction of the materials constituting the Catskill mountain group. If, however, these have been the same as in the preceding sedimentary strata, the force of the current which accumulated the sediment so abundantly along the eastern part of New-York, and spread it to near the western limits of the State, has been too weak to extend the same over the west, corresponding to the zone of the sediments immediately preceding this epoch. We have, therefore, no means of demonstrating by actual continuity of formation, that the epoch of the Catskill group was marked by sedimentary strata in the west.

Directing our observations along the line of the Appalachian chain, we find, succeeding to the coarse conglomerate of the summit of the Catskill mountains, a formation of red shale with calcareous bands, which, in Pennsylvania, attains a thickness of three thousand feet, and is succeeded by the conglomerate of the Coal measures. Whatever may have been the source of this deposit, or the course of the current which transported the material, the formation itself has a very limited westerly extent, and is not known in the Western States. Its precise relations, moreover, to the rocks of the west are not determined, as we shall see farther on, and its fossils are essentially unknown.

At this point in our study of the strata, we should notice a fact of great importance, both in regard to the sequence of formations, and as influencing any general conclusions we may be inclined to draw. We have seen that the series in the west, from the Upper Helderberg group to the Chemung group, is identical in New-York and in the Mississippi valley. From that time to the commencement of the Coal measures, the sequence in the east and west is very different.

The following table of formations will explain their order in the two districts of the country:

Section of strata in New-York and Pennsylvania.	*Section of strata in the Mississippi valley.*
COAL MEASURES,	COAL MEASURES,
	Great Carboniferous limestones of the Mississippi valley. — KASKASKIA LIMESTONE,
RED SHALES,	— FERRUGINOUS SANDSTONE,
CONGLOMERATE,	— ST. LOUIS LIMESTONE,
CATSKILL-MOUNTAIN GROUP,	— WARSAW LIMESTONE,
	— KEOKUK LIMESTONE,
	— BURLINGTON LIMESTONE,
CHEMUNG AND PORTAGE GROUPS,	CHEMUNG AND PORTAGE GROUPS,
HAMILTON GROUP.	HAMILTON GROUP.

That interval of time, which in the east is marked by the accumulation of the Catskill-mountain group (Formations IX and X of the Pennsylvania Survey), and the Red-shale group (Formation XI), is marked in the west by the great Carboniferous limestone series of the Mississippi valley. These formations are widely different in lithological characters, and nowhere commingling, unless it be in the eastern part of Tennessee or in Alabama; and at this time it has not been shown which of these has the precedence. A careful examination of the section on the Mississippi shows such a close sequence between the higher beds of the Chemung group and the lower beds of the Burlington limestone, that we find it difficult to believe that any interval or cessation of deposits has occurred. On the other hand, some beds of coarse material mark the junction of the Chemung group with the base of the Catskill-mountain formation in Eastern New-York; and though the entire fauna of the Chemung group suddenly ceases, there is no evidence of a long interval between the termination of the one and the commencement of the other.

Admitting this view, we have to contemplate a wide extent of country, lying between New-York and the most easterly extension of the Carboniferous limestones, as an area over which no sediments were deposited, nor calcareous formations accumulated, during this period.

It may not be uninteresting in this place to present a few facts relative to this great Carboniferous limestone formation of the Mississippi valley; since, hereafter, in the consideration of the sequence of

formations in New-York, and their relations to the geology of other parts of the United States, this series must form a very prominent feature; nor can we have a clear view of the Palæozoic series, so well displayed in most of its members in New-York, without embracing in our consideration the formations so conspicuous in the exhibition of the ancient subcarboniferous faunæ.

In the Mississippi valley, at several points in Illinois, Iowa and Missouri, the strata of the Chemung group are succeeded by calcareous beds of gray, reddish brown, or ferruginous subcrystalline limestones. Although the line of demarcation is not strongly defined, both the rock and the fauna soon show a strong contrast to that of the group below. The crystalline limestone is a crinoidal limestone *par excellence*. Some portions of the rocks are composed almost wholly of the broken and comminuted remains of this family of fossils; so that, after a little weathering, the mass is scarcely coherent. The higher portions are usually more compact, lighter colored, and often a white semicrystalline limestone.

This formation is more or less fossiliferous throughout, and while remains of Crinoidea are by far the most abundant and important forms, several species of Brachiopoda are very conspicuous. From the readily determined sequence, and the fine exposure of the rock which has afforded so many beautiful fossils at Burlington, Iowa, that name has been proposed to designate this formation.

Next above the Burlington limestone are thick and extensive cherty layers, forming beds of passage to the succeeding formation, the Keokuk limestone, which is well seen at Keokuk, Iowa, and on the opposite side of the Mississippi river in Illinois. This occurs as heavy-bedded bluish or grayish blue subcrystalline limestone with shaly partings, and sometimes with thicker strata of shale and shaly limestone. The same rock occurs in Missouri in numerous localities, always distinct, and recognized by its lithological character and by its fossils. This important formation marks the second stage or epoch in the accumulation of the great limestone series of this period.

In many places the line of separation between this and the succeeding formation is strongly defined by a shaly bed, containing numerous siliceous concretions or geodes. To the Geode bed, and in its absence, to the Keokuk limestone, succeeds a mass of shaly limestone with more compact layers, the whole becoming sometimes altogether calcareous. It is marked by the presence of peculiar Crinoidea and Brachiopoda; but its most characteristic fossil is the peculiar fenestelloid bryozoan known as *Archimedes*, the spiral axes of which are often very abundant upon the surfaces of thin calcareous beds near Warsaw in Illinois. This limestone is more distinctly marked at that place than any other known locality, and hence has received its name. Though clearly distinct in position and fauna, it has many affinities with the succeeding formation.

The Warsaw limestone is followed by a brecciated limestone, which is associated with yellow magnesian beds, and sometimes an arenaceous bed in its lower division. This formation, designated as the St. Louis limestone by Professor SWALLOW in his Geological Report of Missouri, varies from a brecciated mass to a regularly stratified gray limestone, with some important beds of light gray subcrystalline limestone. The rock is well marked by its peculiar organisms, the beautiful *Echinocidarus* (*Palæchinus multipora* of OWEN and NORWOOD), being one of its most conspicuous forms. Numerous Bryozoa cover the surfaces of some of the layers, which are separated by shaly partings; while the *Lithostrotion mamillare*, the most conspicuous coral of all the limestones of the Mississippi valley, marks this horizon.

The St. Louis limestone is limited above by a ferruginous sandstone, a mass of nearly two hundred feet thick. This sandstone marks, over a considerable area, the cessation of calcareous accumulations, and is a precursory influx of the arenaceous material which, in the sandstones of the Coal measures, followed the conclusion of the calcareous series. This formation occurs in Missouri and in Illinois, at numerous localities, but thus far little is known of its organic contents.

The Ferruginous sandstone is succeeded by a limestone formation, having lithological affinities with the lower limestone, but very distinctive in its organic remains. The Kaskaskia limestone is a well marked group, consisting of gray or ferruginous subcrystalline beds of dark-colored limestone, with shaly partings, and sometimes with thick seams and beds of shale; with intercalated beds of sandstone, and of shale, sometimes with land plants. The fauna is everywhere distinctive, though consisting mainly of genera known in the lower limestones, and marked also by the presence of *Archimedes*. The crinoidean fauna, so characteristic of the Carboniferous limestone series, has few species of the actinocrinoid type, and fewer *Platycrinus* than the Burlington and Keokuk limestones; while *Poteriocrinus* is much more fully developed, and the species of *Zeacrinus* and *Scaphiocrinus* become the most numerous and important forms.

The Kaskaskia limestone is the uppermost member of what I have termed the Carboniferous limestone formation of the Mississippi valley. To it succeeds the Coal measures in the true order of sequence; though, as we shall find, the series is interrupted, and the rocks of that period do not always rest on this group of limestones.

In considering the geographical distribution of the groups of strata, there are many interesting facts in connection with the conditions attending the accumulation and deposition of these limestones.

The lowest or Burlington limestone has the greatest northerly extension, and the northern outcrop of the Kaskaskia limestone, so far as we know, never approaches within one or two hundred miles of it; and we have also satisfactory proof that this absence of the upper limestone is not due to denudation, but that these were the limits of original accumulation on the north.

In tracing these several formations to the southward, we find that the Burlington limestone has its most perfect development north of the parallel of the Ohio river. In Tennessee and Alabama the place of this formation is represented by the cherty beds, constituting a part of what is there known as the "Siliceous group," and a very partial exhibition

of its fauna is manifested at intervals in a few feet of limestone lying below these siliceous beds.

The northern outcrops of the Keokuk, Warsaw, and St. Louis limestones are also farther north than that of the Kaskaskia, while in the south they have so far thinned out as to form no important feature; nevertheless the fauna is in many places partially represented, and it is probable that more careful examinations may develop a clearer distinction among the members of the series, when their relations and their fauna in more northerly localities shall have been fully studied.

Thus, at the south, it would have been impossible to establish the sequence; nor could it well have been established by investigations progressing from south to north. It is necessary to trace them from their northern outcrops southward, in order to have a full appreciation of these different members and their relations, to become acquainted with each rock in its order, and to learn its distinctive fauna. To an investigator of the Carboniferous limestone in Tennessee and Alabama, the mass is essentially a unit, and the condition of the lower fauna is not such as to be readily suggestive of subdivision. But from a northern point of view, each period is seen to have had a distinctive accumulation; each one is marked by its fauna, indicating a change in the conditions of the bottom or depth of the ocean; each successive period, while having the greatest development in the north, has witnessed a recession of the Carboniferous sea towards the south. This gradual recession has continued to the period of the Kaskaskia limestone, while the maximum development of this formation lies in an area over which the preceding deposits were but thinly accumulated. In the period of the Kaskaskia limestone, we find also a maximum development of animal life, and the grand culmination of that fauna which preceded the Coal measure period.

The nature of these accumulations, the condition of the ocean bed, and the character of the fauna, with the varying limits of the waters of that period, are all so different from any conditions existing in the east during the interval between the Chemung group and of the Coal

formation, that it is impossible at the present time to parallelize the deposits of these two regions of country. It is only by a consideration of the physical conditions of the period that we may arrive at some conclusion.

From the gradual recession of the ocean to the southward during the deposition of these limestones, and the manner of their overlapping, it is evident that there is a certain degree of unconformity among the members of the series. This becomes more manifest when we carry our examinations into the Coal measures, which lie unconformably over all these limestones, except, perhaps, the upper one; and also, to some extent, over the Devonian and Silurian rocks beneath.

The recession, and the consequent unconformability, could only have resulted from a movement in the pre-existing land or sea bottom. Further evidences of such a movement are to be seen in the Cincinnati axis, which, extending from Canada to Tennessee, has elevated the lower rocks; and it may be that the movement producing this axis was initiated prior to the deposition of these limestones.

Admitting this view of the subject, the elevation of that axis, or the subsidence of the sea bottom on the east and on the west, may have so far divided the waters that the sediments derived from the east were not carried beyond that line; while to the west there may have been a quiet, shallow sea, fitted for the development of these faunas, and for the accumulation of the calcareous material forming this great series of limestones. This view may be sustained by the fact that nowhere, so far as I know, do the Carboniferous limestones appear beneath the Coal measures on the east of the Cincinnati axis, in Ohio or Kentucky.

I regard this question as one open for investigation; and we shall arrive at a true solution of the problem much sooner by studying the long lines of outcrop in the west, than by any discussion of probable physical conditions. It is a question of the highest interest for the true exposition of our geology.

By tracing the direction of these geological formations on the east and west, we cannot fail to observe a convergence to the southward; and it is there, if at all, that facts are to be obtained that will show conclusively the relative age or synchronism of these formations lying between the Coal measures and the Chemung group.

At the commencement of the Coal-measure deposits, we find a return to those conditions which have prevailed during all the preceding important sedimentary groups. This formation exists in Nova-Scotia and New-Brunswick, and again in Pennsylvania, stretching southward into Alabama; while to the west it extends with slight interruptions, but with diminishing thickness, far beyond the Mississippi river.

The thickness of this formation in Nova-Scotia, according to the careful measurements of Sir WILLIAM LOGAN, is more than fourteen thousand feet. In Pennsylvania, Professor ROGERS states it, including the conglomerate, at more than eight thousand feet*. Taking these as initial points, and carrying our observations to the west and southwest, we find a constantly diminishing thickness in that direction, and finally the entire formation is represented by a few hundred feet of strata.

The measurements of Professor SWALLOW, in Missouri, give six hundred and forty feet as the thickness of the Coal measures proper; and in Iowa the amount is still less.

The great Conglomerate which lies at the base of the formation, and in Pennsylvania measures fourteen hundred feet, appears in considerable force in Ohio and in Indiana, but has entirely thinned out before reaching the Mississippi river. Of the other members of the formation, the coarser materials have diminished, and the Coal measures in the west are composed of finer sediments than in the east.

Thus we see everywhere the operation of the same law, viz. a greater accumulation, and a coarser character of sediments along the line of the Appalachian chain, with a gradual thinning to the westward, and a deposition of the finer or far transported matter in that direction. In

* Even admitting, as has been claimed by some, that this thickness is over-estimated, a difference of one or two thousand feet would not affect our general conclusions.

all the great periods of sedimentary deposits which we have considered, or the transportation of shore-derived materials, this law has held true, and has governed the distribution, or the cause that originated these conditions, long before the distribution and deposition of the material commenced, giving form and contour to the eastern part of our continent, to its mountain ranges, and their elevation.

It may further be observed that the Coal measure formation is the last which has followed this order of distribution.

In contemplating the origin and character of the sediments forming the Coal measures of the United States, we are at once impressed with the fact that they consist largely of land-derived materials, and that plants of land origin mark the successive beds of which they are composed. Here, then, we have positive evidence of that condition of things which was before inferred in the lower formations. It is seen that in the period of the Hudson-river group, we have coarse and fine sediments, evidently of shore origin, or at least from land near the surface of the ocean. These deposits are marked only by a marine fauna, and the few plant-like bodies are like the Fuci or seaweeds of modern times. No plant of land growth has been seen in the deposits of this age. It is not until we come to the Hamilton group that we find remains of land plants, few and fragmentary (in the State of New-York), as if drifted far out to sea from some sparse flora of a recent land. In the Portage or Chemung groups we have a larger number of species, and numerous specimens, all appearing as if far drifted. As we rise in the series there is a gradual increase in the flora, or the waves of the abrading ocean and the tranporting currents have farther encroached upon the land from which they are derived. Towards the west these remains disappear, and I am not aware, at this time, that any fragment of a plant has been found in either the Hamilton, Portage, or Chemung groups in the Mississippi valley.

On the other hand, when we trace these strata towards the northeast, or in the direction which we suppose may have been their source, the fragments of plants become more numerous and the flora of larger size.

Sir WILLIAM LOGAN has obtained from strata of this age, in Gaspe, fragments of the trunk of a tree several inches in diameter; and the abundant distribution of plants in that region indicates a proximity to their source, or that they are now imbedded in the soil where they grew.

In the Coal measures proper, we find a similar state of things, with the mass of material much greater, the remains of a former flora extremely abundant and widely diffused, and the indications still stronger that, to a great extent, the area occupied by these strata was the land on which the plants flourished; that they were destroyed by successive inundations or submergences, when the overflow of the waters bore with them the coarser materials which covered the pre-existing flora.

In Nova-Scotia, with the profusion of land plants, there occur also remains of land shells: in Pennsylvania, and nearly all the more easterly Coal measures, land plants are abundant.

These conditions, however, whatever they may have been, declined towards the west. The shore-derived material has extended only partially over the area; and there is in that direction not only a thinning of the entire mass, but also a paucity of plant remains.

There is, moreover, a large accession of calcareous matter in that direction. On comparing the sections of Professor SWALLOW, which are given in great detail, we find everywhere, but more particularly in the two upper divisions, a large proportion of calcareous material in the form of argillaceous shale, marl, etc., with numerous marine shells. The same is true of the Coal measures in the west: in Iowa, Illinois, and Indiana, we find an approach to this character. In Pennsylvania calcareous bands are few, and in extremely small proportion, increasing in Ohio and the west; while in Nova-Scotia, calcareous beds form a very insignificant proportion of the whole.

This condition is only to be explained by supposing, as we have moreover evidence in proof, that the Coal measure sediments were driven westward into an ocean where there already existed a well marked marine fauna. This part of the ocean bed was subject to oscillations, and at times

of shallow water the land-derived materials and the low lands themselves were pushed farther to the westward, encroaching upon the ancient sea: at other times the marine influences and marine deposits prevailed, and the soft and finely comminuted material spread over the bottom was mingled with the exuviæ of marine animals, forming a calcareous shale or an argillaceous limestone. The presence of this ocean is marked in Eastern Ohio by a band of limestone several feet in thickness, containing marine shells of the same species which prevail more abundantly and through a much greater thickness of calcareous strata in Iowa and Missouri. The accumulation of such a bed of limestone, made up in large proportion of the exuviæ of marine animals, could only have been made during a quiet interval, when the surface was submerged to a considerable depth, and while there was no influx of shore-derived materials.

The calcareous matter goes on increasing westward; the marine fauna becomes more and more abundant, until we find ourselves gradually leaving the shore-derived materials, and coming among those which are wholly of marine origin. In the same proportion the characteristic feature of the formation, the coal, will be found to diminish, and we must be prepared to learn that the productive portion of the Coal measures do ultimately give place, in great part or entirely, to the marine portions of the formation, which increase towards the west in force and importance.

To my own view, we find in the Coal measure formation the culmination of that order of things which commences with the Hamilton group, was expressed but feebly in the beginning, but growing stronger and stronger through the Portage, Chemung and Catskill-mountain periods, finds its full expression in the Coal period.

But even this condition, gradually initiated, long continued, and wide spread as it is on this continent, is not the universal expression of that period in the geological history of the world. Nor is this peculiar flora, existing through so long a period, and widely distributed as it is, to be regarded as the universally marked period of plant life. It so happens that from the stand-point which we occupy, this feature is more strongly impressed, and more widely and fully expressed than any other which we

know in this geological period. We shall see, however, that the Coal period, so important geologically, may in other regions be partially or entirely destitute of this mineral, and not distinguishable by the usual characteristics in which we ordinarily recognize the rocks of this period.

The prevailing fossil species occurring in the calcareous bands of this formation in its more easterly extension, are *Spirifer cameratus**, *S. lineatus*, *Terebratula subtilita*, *T. millepunctata*†, *Productus rogersi*, *P. semireticulatus*, etc. The species named are usually associated in all the localities examined from Eastern Ohio to the Mississippi river. With the increase of calcareous matter farther west, we find a larger number of species. In the collection made by Captain STANSBURY on his route to the Great Salt Lake, in the collections of the Pacific railroad explorations, and in those made by Dr. ROEMER from Texas, as well as in collections from other sources, several of the species cited above have been identified.

At the same time, while these western explorations bring us from every point marine fossils of the age of the Coal measures, there are no accompanying plants. Neither have any of these collections shown fossils of the Lower Carboniferous limestones, or those which lie beneath the Coal measures. All the fossils from the Rocky mountains, which have been cited as the Lower Carboniferous limestone, have proved to be, so far as I know, of species belonging to the period of the Coal measures; and we are at this time without evidence of the existence of the Lower Carboniferous limestone in the Rocky mountains‡.

From a comparison of all the fossils which have come under my observation, I am forced to the conclusion, that the great limestone formations which extend for long distances continuously in the Rocky mountains, and which are known to extend from the limits of the Northern ocean to

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* This species has been described by Dr. ROEMER as *S. meusebachanus* (ROEMER, *Kreid von Texas*), and by myself as *S. triplicatus*; while Dr. OWEN has identified it with *S. fasciger* of KEYSERLING. It is undoubtedly the *S. cameratus* of MORTON, which name has precedence over all the others.

† It is possible that the species described as *T. bovidens*, by Dr. MORTON, may undergo such variations as to include forms like *T. millepunctata*. This cannot be decided, without a larger collection of specimens than I possess at present.

‡ See Report on the United States and Mexican Boundary Survey.

the Gulf of Mexico, belong to the same limestones which in the Coal measures of Ohio and other Western States, appear in bands of a few feet in thickness.

From the Report of Captain STANSBURY*, we learn that extensive mountains, or even ranges of mountains, in the neighborhood of the Great Salt Lake are composed of this Upper Carboniferous limestone. Some of these mountains have an elevation of three thousand feet above the plain; and, though quite unaltered in their condition, rest upon metamorphic strata, similar in character to those of the Appalachian range. This limestone has been identified by its fossils in the neighborhood of Fort Laramie: it is known from observations along the line of the United States and Mexico Boundary Survey; it is also known from collections made near Santa Fe, New-Mexico, at the Pecos village, the Mogollon mountains, at El Paso on the River San Pedro, in the Gaudaloupe mountains, and many other localities. From the massiveness and compact texture of some specimens, and the subcrystalline character of others, we are prepared to learn that this rock has become extensively developed in that region. The shaly beds which accompany this limestone in its more northern and eastern localities, and are there often more conspicuous than the limestone itself, have so far diminished that they form no marked feature in the topography; nor has this character been shown in any of the sections of strata which I have seen from that region.

It is either at the base of this formation, or associated with the limestone itself, that we are to look for productive Coal measures; but up to this time, we have no positive information that coal has been found in this association in the northwest†. Farther to the southwest, the occurrence of coal has been mentioned by several explorers of that region. Several specimens of coal accompanied the collections made by the naturalists of the United States and Mexican Boundary Survey, but these were not accom-

* STANSBURY, Expedition to the Great Salt Lake, 1852.

† The collections made by Captain STANSBURY, in his Expedition to the Salt Lake, contain some slaty coal and shale; and the occurrence of *Sigillaria* and *Calamites* is mentioned in the journal of the naturalist accompanying the expedition. No fossils of this character were preserved in the collections, and there may still remain some question in regard to this matter, until we have farther information.

panied by evidences of their relations to the true Coal measures. At the same time, several writers have cited the occurrence of true Coal measures in this region of country.

In any event, however, it seems quite probable that the coal, and the shales and sandstones which usually accompany it, have so far thinned out as to be of comparatively little importance in the series. Whether this conclusion prove wholly correct or otherwise, in regard to this part of the country, it is evident that when we find the calcareous accumulations so far preponderating over all the other materials, such must be the ultimate result, unless some other source of land-derived materials shall be found. We are led to anticipate this latter condition from the occurrence, in the central and western parts of the continent, of large accumulations of the older palæozoic sediments which are evidently derived from a different source, and have had a different direction in their distribution. It is possible, therefore, that there may have been other sources for the derivation of terrestrial vegetation and shore-derived materials during the Coal period.

Whatever may have been the ancient condition of the central part of this continent, it is clear, from what we know of the great extent of the limestone of this age, that the ocean must have held entire dominion over this region for a long period, even after the final deposition of these limestones*.

Thus the Carboniferous period, so designated from its characteristic coal-fields in the region where the formation was first explored and studied, cannot, from our present knowledge, be considered universally the period of vegetation. Had our observations begun in the Rocky mountains, and extended over the area from the Northern ocean to the Gulf of Mexico, we should nowhere have found reasons to designate this as pre-eminently a plant-bearing period. On the contrary, it is everywhere in that region characterized by its fossils of marine origin, and in truth is apparently one of the most, if not the most, extensive marine formation upon our conti-

* At the time of this writing, the series of strata between the limestones of the age of the Coal measures and the beginning of the Cretaceous period, have not yet been sufficiently explored to speak with certainty of the conditions which existed during this interval.

nent, and characterized over a much wider area by its marine animal remains, than by the remains of terrestrial vegetation in the present known areas of the Coal measures on the east of the Rocky mountains.

With the termination of the Coal measures of the eastern part of our continent, ceased the sedimentary deposits, which for so long a period accumulated along the line of the Appalachian chain. At this time or subsequently, and before any deposits in direct sequence had been made, the whole eastern region appears to have emerged from the ocean.

It is true that we still find sediments of a newer era on the eastern flanks of this mountain range, in Nova-Scotia, in the Connecticut river valley, and in New-Jersey, Pennsylvania, Virginia and North-Carolina, which have a trend in the same direction; but it is not yet proved, so far as I know, that the source of these formations was the same as that of the older deposits, and they are not in direct sequence. Along this line these accumulations, which are somewhat disconnected, may have been influenced by proximity to coast lines, and not by any strongly marked ocean current in that direction.

The accumulations of the Coal period were the last that have given form and contour to the eastern side of our continent, from the Gulf of St. Lawrence to the Gulf of Mexico. And as we have shown that the great sedimentary deposits of successive periods have followed essentially the same course, parallel to the mountain ranges, we very naturally inquire : What influence has this accumulation had upon the topography of our country? and is the present line of mountain elevation, from northeast to southwest, in any manner connected with this original accumulation of sediments?

I have all along shown that the sedimentary deposits are greatly thicker in the eastern than in the western localities, and that for the most part they are extremely poor in calcareous matter; while generally the limestone formations, individually and in the aggregate, are thicker at some distance west of the line of greatest sedimentary accumulations.

An approximate measurement of all the strata along the Appalachian chain gives an aggregate thickness of forty thousand feet, while the same formations in the Mississippi valley measure scarcely four thousand feet; in this, also, are included the Carboniferous limestones, which do not exist in any eastern section.

In the Mississippi valley we have numerous points where the Lower Silurian strata are exposed, and at some points there is a thickness of five hundred feet of the Potsdam sandstone. From this base we follow the series upwards to the top of the mounds, capped by the Niagara limestone; and we there attain an elevation above the Mississippi waters of one thousand feet, which is the whole thickness of the formations from the Potsdam sandstone to the Niagara limestone. The actual measurement of the same set of strata in the Appalachian region would give us more than sixteen thousand feet; and even making large allowances for excess in the measurements, we certainly have, in the Appalachians, more than ten times the thickness of the entire series in the west. Still we have no mountains of this altitude; that is to say, we have no mountains whose altitude equals the actual vertical thickness of the strata composing them.

In the west there has been little or no disturbance, and our highest elevations of land mark essentially the aggregate thickness of the strata which produce the elevation. In the east, though we prove step by step that certain members of the series, with a known thickness, are included in these mountains, the altitude never reaches the aggregate amount of the formations. Reasoning from the facts adduced, and without prejudice or theory, the result certainly does not agree with our anticipations; for on the one hand, we find in a country not mountainous, elevations corresponding essentially to the thickness of the strata; while in a mountainous country, where the strata are immensely thicker, the mountain heights bear no comparative proportion to the thickness of the strata.

We have seen that one simple and intelligible sequence of strata, from the Potsdam sandstone to the end of the Coal measures, covers,

with small exceptions, the entire country from the Atlantic slopes to the base of the Rocky mountains; that the same geological formations occupy the mountain chain and the plateau. But while the horizontal strata give their whole elevation to the highest parts of the plain, we find the same beds folded and contorted in the mountain region, and giving to the mountain elevation not one-sixth of their actual measurement.

We are accustomed to believe that mountains are produced by upheaval, folding and plication of the strata; and that from some unexplained cause, these lines of elevation extend along certain directions, gradually dying out on either side, and subsiding at one or each extremity. In these pages, I believe I have shown conclusively that the line of accumulation of sediments has been along the direction of the Appalachian chain; and, with slight variations at different epochs, the course of the current has been essentially the same throughout. The line of our mountain chain, and of the ancient oceanic current which deposited these sediments, is therefore coincident and parallel; or, the line of the greatest accumulation is the line of the mountain chain. In other words, the great Appalachian barrier is due to original deposition of materials, and not to any subsequent action or influence breaking up and dislocating the strata of which it is composed.

To be satisfied of this, it seems only necessary to compare the eastern and western exposures of the formations; for here the valleys, cutting through the rocks of the several groups down to the lower limestones, or to the Potsdam sandstone, present mountain ranges of several thousand feet on either side; while in the valley of the Mississippi, where the strata have thinned, the same denuding action has produced low cliffs or sloping banks of one or two hundred feet in height. Therefore had the country been evenly elevated without metamorphism or folding of the strata, making the lowest palæozoic rocks the base line, in the States bordering the Atlantic we should have had higher mountains and deeper valleys, wherever the series was complete. At the same time, the great plateau on either side of the Mississippi river would have

presented the features it now does, of valleys extending to the Lower Palæozoic beds, with cliffs of the height represented by the actual thickness of the beds which there constitute the entire series.

The gradual declination of the country westward is due primarily to the thinning out of all the formations which have accumulated with such great force in the Appalachian region. It is also susceptible of proof, that no beds of older date have contributed to elevate the later ones, or to form a part of the mountain chain.

We have in the east one example where the conditions of elevation correspond with those in the Mississippi valley. The Catskill mountains are composed almost entirely of strata in a horizontal or very slightly inclined position; the Hudson-river group, which constitutes a few feet of their elevation at the base, is disturbed, and the succeeding beds lie upon this unconformably. These mountains, therefore, rising to a height of 3800 feet above tidewater, mark in their altitude simply the vertical thickness of the strata.

At this point of our inquiry, several questions of importance present themselves: First, what has been the cause of this folding and plication of the strata; secondly, having been thus folded and plicated, what influence has this action exerted upon the elevation of the parts, or of the whole; and thirdly, what effects are due to the metamorphism which accompanies this mountain chain?

It has been long since shown that the removal of large quantities of sediment from one part of the earth's crust, and its transportation and deposition in another, may not only produce oscillations, but that chemical and dynamical action are the necessary consequences of large accumulations of sedimentary matter over certain areas. When these are spread along a belt of sea bottom, as originally in the line of the Appalachian chain, the first effect of this great augmentation of matter would be to produce a yielding of the earth's crust beneath, and a gradual subsidence will be the consequence. We have evidence of this subsidence in the great amount of material accumulated; for we cannot suppose that the sea has been originally as deep as the thickness of

these accumulations. On the contrary, the evidences from ripplemarks, marine plants, and other conditions, prove that the sea in which these deposits have been successively made was at all times shallow, or of moderate depth. The accumulation, therefore, could only have been made by a gradual or periodical subsidence of the ocean bed; and we may then inquire, what would be the result of such subsidence upon the accumulated stratified sediments spread over the sea bottom?

The line of greatest depression would be along the line of greatest accumulation; and in the direction of the thinning margins of the deposit, the depression would be less. By this process of subsidence, as the lower side becomes gradually curved, there must follow, as a consequence, rents and fractures upon that side; or the diminished width of surface above, caused by this curving below, will produce wrinkles and foldings of the strata. That there may be rents or fractures of the strata beneath is very probable, and into these may rush the fluid or semifluid matter from below, producing trap-dykes; but the folding of strata seems to me a very natural and inevitable consequence of the process of subsidence.

The sinking down of the mass produces a great synclinal axis; and within this axis, whether on a large or small scale, will be produced numerous smaller synclinal and anticlinal axes. And the same is true of every synclinal axis, where the condition of the beds is such as to admit of a careful examination*. I hold, therefore, that it is impossible to have any subsidence along a certain line of the earth's crust, from the accumulation of sediments, without producing the phenomena which are observed in the Appalachian and other mountain ranges†.

That this subsidence was periodical, we have the best possible evidence in the unconformability of the Lower Helderberg group upon the Hudson-river group; showing that previous to the deposition of these

* I am indebted to Sir WILLIAM LOGAN for this latter suggestion, as the result of his very accurate and extensive observations on the relations of anticlinal and synclinal axes.

† To have an idea of this folding, it is only necessary to take a package of flat sheets of paper, and hold the edges firmly in the same position and relation they had when in a horizontal position, depressing the centre, and as the lower sheets assume the curved direction the upper ones will curve

limestones, there were already foldings and plications, the consequence of a subsidence along the line of accumulation. Subsequently to the deposition of the latter formations, or at intervals during their accumulation, there have been other periods of subsidence, and consequently of folding and plication; so that these are not synchronous, nor are they conformable with each other.

This successive accumulation, and the consequent depression of the crust along this line, serves only to make more conspicuous the feature which appears to be the great characteristic, that the range of mountains is the great synclinal axis, and the anticlinals within it are due to the same cause which produced the synclinal; and as a consequence, these smaller anticlinals, and their correspondent synclinals, gradually decline towards the margin of the great synclinal axis, or towards the margin of the zone of depression which corresponds to the zone of greatest accumulation*.

This affords a partial explanation of the fact already observed, that the mountain elevations in the disturbed regions bear in their altitude a much smaller proportion to the actual thickness of the formations, than do the hills in undisturbed regions. Furthermore it so happens that so soon as disturbance takes place and anticlinals are formed, the beds are weakened at the arching, and become more liable to

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upwards or wrinkle. This is an illustration after a different manner of the old elementary process of producing foldings in sheets of paper, as illustrative of folded strata by lateral presure. Now, as a set of strata one or two hundred miles in width cannot slide over each other, as sheets of paper do if left to themselves during the process of depression, the beds on the lower side must either become extremely broken, or the higher portions become folded and plicated. That some fractures will take place below there can be no doubt, and these are probably such as we see filled with trappean matter. But the greater movement would undoubtedly take place in the higher beds, which necessarily assume positions and relations such as have been pointed out. This condition and manner of movement offers, moreover, an explanation of the form of trap-dykes, which are often narrower above in the synclinals and on synclinal slopes, the matter filling a fracture opened from below; while in the case of such matter penetrating an anticlinal, it would necessarily widen above from the reversed conditions attending the fracture.

* This mode of depression, which is the result of accumulation, and the production of numerous synclinal and anticlinal axes offers a satisfactory explanation, as it appears to me, of the difference of slope on the two sides of the anticlinals which have been so often pointed out as occurring in the Appallachian range, where the dips on one side are uniformly steeper than on the other.

denuding action. Thus the anticlinals are often worn down to such an extent as to form low grounds or deep valleys; while the synclinal, protected in the downward curving of the beds, remains to form the prominent mountain crest. This is very generally true in many parts of the Appalachian range; and it is only where some heavier or stronger bedded rock occurs, protecting the anticlinals, that they form the higher mountain elevations. Similar features will be observed in other mountain ranges*.

It nowhere appears that this folding or plication has contributed to the altitude of the mountains : on the other hand, as I think can be shown, the more extreme this plication, the more it will conduce to the general degradation of the mass, whenever subjected to denuding agencies. The number and abruptness of the foldings will depend upon the width of the zone which is depressed, and the depth of the depression, which is itself dependent on the amount of accumulation.

We have, therefore, this other element of depression to consider, when we compare mountain elevations with the thickness of the original deposition.

It is possible that the suggestion may be made, that if the folding and plication be the result of a sinking or depression of the mass, then these wrinkles would be removed on the subsequent elevation; and the beds might assume, in a degree at least, their original position. But this is not the mode of elevation. The elevation has been one of continental, and not of local origin; and there is no more evidence of local elevation along the Appalachian chain, than there is along the plateau in the west. As it is, a large mass of the matter constituting the sediments of this mountain range still remain below the sea level, as a necessary consequence of the great accumulation; while in the

* The sections of the Geological Survey of Great Britain exhibit numerous examples of this kind. On the geological map of Great Britain, a section across the country presents us with Snowden summit as a synclinal, the height of which is much less than the thickness of the strata from the Longmynd to the Caradoc; while, had the bedded trap of Moel Wyn and Aran Mowddwy, and its superincumbent strata, been sufficiently strong to have resisted denudation, the anticlinal axis would have presented a mountain far higher than Snowden.

the blackened, shining, and sometimes striated surfaces, more or less conspicuous. The mass presents an appearance as if there had been a movement within itself, or as if it had been partially crushed by the folding, producing a sliding of the fragments over each other. This condition is not universal; and some portions still retain their lamination, breaking in large pieces, but with numerous faults, the terminations or faces of the faults showing smooth, glazed surfaces, while the continuation of the laminæ, if traceable, is not found in the same line; and an intermediate space is often filled with soft, crushed, shaly matter. Calcareous seams often accompany this condition of the shales. At the same time the heavier arenaceous and argillo-arenaceous layers become harder and more compact, changing somewhat in color, and developing crystalline matter in the joints*.

Still nearer to the mountain range the same shales are more broken, and changed in color; while between the laminæ we observe shining particles of a talc-like substance, and finally this becomes a predominating feature.

In the same stages of progress, the limestones gradually lose their dark color, and numerous ramifying veins of calcareous spar traverse the mass. The fossils lose the definiteness of their forms, and often become much distorted. In the impure limestones we soon find numerous, shaly and micaceous interlaminations, and the mass gradually assumes a crystalline structure. Still, long after the crystalline texture becomes marked, the weathered surfaces may show the remains of fossils, the fragments of Crinoidea being among the last to disappear,

* In the careful study of the strata, when in this condition, for the purpose of tracing some thin fossiliferous band, we not unfrequently find some hard lamina of an inch or more in thickness, traversed by several faults in the space of a few inches. Sometimes these faults are not more than an eighth or a quarter of an inch, and are not unfrequently seen to affect one-half of a specimen, dying out in the space of a few inches. Again, these faults are of the extent of an inch or more, and not unfrequently a hard slaty layer of one or two inches in thickness is entirely cut off by such faults, and the parts separated by soft shaly matter thrust in between them. In some parts of the folding or axis it is often difficult to follow these harder layers in their frequent fracturing and displacement, obscured by the intervention of the softer matter.

as the mass becomes a homogeneous, crystalline limestone*. And it is interesting to observe that while the normal characters of the rocks become so completely disguised, and the entire mass is essentially crystalline throughout, there are these indications of the original condition in the preservation of fossils.

At this time it is scarcely necessary to present facts or arguments to show that this metamorphism has not proceeded from the contact or proximity of older granitic or other rocks supposed to be of plutonic origin. The influence of trap-dykes can have had nothing to do with producing the change; and as to a supposed granitic mass or nucleus underlying these strata, it exists only in theory, for we have no positive and tangible evidence of such a nucleus. It is true that in the Appalachian chain there are masses and even considerable areas of what is termed eruptive or intrusive granite; but the existence of such granite furnishes no evidence that it is derived from a primary mass, or that it has been erupted in a state of igneous fusion. Such masses of granite may, indeed, and very probably have been derived from the formation immediately beneath the one on which it rests; and it is almost certainly in all cases a modification of some pre-existing sedimentary rock. We are well aware that the Laurentian mountains of Canada, and the mountains of the same age in Northern New-York, are metamorphosed sedimentary strata; and we have to look for the intervention of some of the thinning strata of these formations beneath the Appalachians, before we reach the hypothetical plutonic mass below.

Perhaps there is no fact of more interest and significance in connection with these older long designated primary formations of the Laurentian range, than the discovery of Sir WILLIAM LOGAN that these crystalline masses do enclose fragments of pre-existing stratified rocks; these fragments still retaining the original lines of lamination.

* It is not uncommon to find upon the weathered surfaces of the crystalline limestones, in Western Massachusetts and the adjacent parts of Vermont, fragments of crinoidal columns, and joints of the same, which preserve the unmistakable structure of these fossils.

Whatever may have been the cause of metamorphism or crystalline structure, even in these old Laurentian rocks, it becomes clear that they were derived from pre-existing sedimentary strata; and that masses of that prior formation, with its lamination still shown, are preserved in the most ancient crystalline rocks yet known upon the globe*. These facts furnish proof, moreover, that the mass has never been subjected to that high degree of heat which is usually supposed to accompany the production of crystalline granite.

Returning, therefore, to the consideration of the metamorphic rocks of the Appalachian chain, we shall nowhere find evidence of extensive metamorphism produced by contact or proximity of a metamorphosing agent. The Laurentian rocks, on which rests the Potsdam sandstone, the lowest of the Appalachian series, had been metamorphosed, and the present mountain ranges formed long anterior to the time of the deposition of this oldest of the palæozoic rocks. Even could we for a moment suppose it to be true that the contact of the granite or other so-called plutonic rock could change the entire mass through thousands of feet vertically, and many miles in extent laterally, beyond the limits of its contact, then we should necessarily expect to find that in the immediate vicinity of intrusive granites the surrounding mass would be more changed than at a distance from that point; but such is rarely the fact. Indeed at the present time few geologists, I think, are willing to maintain that metamorphism has been caused, in any important degree or extent, by intrusive rocks. The influence, whatever it may be, has permeated the entire mass of sediments, independent of all surrounding influences, or of contact or proximity of heated or melted masses.

That these mountain masses, in their great depression beneath the present sea level, may have reached a point where the surrounding temperature was much higher, is doubtless true, and this increase of

* These rocks of the Laurentian mountains of Canada and the Adirondacks of New-York, from all their relations to newer formations, and in mineral association, are probably identical with the gneissoid and granitic rocks of the north of Europe, and we do not yet know of any extensive formations of more ancient date.

temperature has permeated the entire mass. Still such an increase of temperature would be much less than that usually supposed necessary for producing metamorphism; and it is extremely doubtful if any portion now exposed to observation ever reached a temperature much above that of boiling water*. We must therefore look to some other agency than heat for the production of the phenomena witnessed; and it seems that the prime cause must have existed within the material itself, and that the entire change is due to motion, or fermentation and pressure, aided by a moderate increase of temperature producing chemical change. The chemical investigations in the Canada Geological Survey, carried on by Mr. T. Sterry Hunt, have shown that the unmetamorphosed rocks of the lower part of the Appalachian chain, or those of the age of the Hudson-river group, contain the same mineral substances and in precisely the same proportions as the metamorphosed crystalline and subcrystalline beds of the adjacent region, where the segregated minerals become palpable and visible†. Moreover, in the same survey the identity of the metamorphic and non-metamorphic rocks had been determined by actual continuity of the beds.

Without intending to discuss the chemical question, it seems to me that the first requisite of metamorphism is the aggregation or accumulation of sedimentary matter and chemical precipitates in large quantities and in great thickness upon the sea bottom. Over the entire area, where these older deposits are thin, there is no evidence of pervading

* Whatever this temperature may have been, it was doubtless the same, and no other, that would be reached by penetrating to an equal depth beneath the crust; and in the process of depression of these sedimentary strata, they have unquestionably reached a comparatively high degree of temperature. Or to speak in accordance with the ordinarily accepted view, the accumulation of the sediments has disturbed the equilibrium of temperature, causing a rise, or movement towards the surface, of the isothermal lines or strata, corresponding to the amount or thickness of the accumulation. But if we look a little farther at this matter, and admitting that there is a maximum thickness of forty thousand feet, we cannot suppose that the metamorphosed portions now exposed have ever reached this depth below the surface, or a temperature corresponding to such depth below the surface. On the other hand, I do not suppose that those parts now visible have reached a temperature, or have been depressed to the extent, of an equivalent of twenty thousand feet.

† The investigations of Mr. Hunt, in this direction, are bringing out results of the highest interest, and such as will, I believe, when combined, achieve a complete revolution in this department of geological science.

metamorphism. It is only as we approach the zone of great accumulation, that we begin to find evidence of metamorphism on a grand scale. In this mountain range, and I believe also in others, the line of metamorphic action is parallel to the mountain chain, and parallel to the minor elevations or subordinate axes of the great mass; parallel, indeed, to the great line of original accumulation of the sediments constituting the mountain mass*.

In accordance with the views I have advanced relative to the accumulation of matter along certain zones, and the consequent subsidence, I have also endeavored to reach some explanation for the great extrusion of trappean matter in certain regions of country.

The rocks of the Laurentian age, in their great accumulation, are here and there cut by trap-dykes of moderate dimensions; and the same is true of the metamorphic rocks of palæozoic age along the Appalachian range, and sometimes even beyond the limits of the mountain region. The large accumulations of basaltic or trappean matter which are geographically associated with this range of mountains, belong to a later geological period.

We may not infer, however, from these facts, that there were no extensive outbursts of trappean matter during these more ancient geological periods. In the Lake Superior region, we have extensive trappean accumulations in the period of the Potsdam sandstone; in Nova-Scotia, during the period of the New Red sandstone; and in the Connecticut and Hudson-river valleys and elsewhere, connected with a newer sandstone. The great trappean accumulations in the Rocky

* What I have here said of accumulation and consequent metamorphism, seems to find some confirmation in the condition of some of the beds near the base of the Catskill mountains, where, although essentially horizontal, they are nevertheless extremely hard and dense; having, indeed, more the appearance of a metamorphic rock than many of the beds on the western flanks of the Green-mountain range, where folding and plication are exhibited on a grand scale. Whatever reason there may be for the hardness and density, and the incipient subcrystalline condition of these beds, placed beneath more than three thousand feet of accumulated strata, the same beds traced westerly towards the centre of the State do not exhibit the same hardness or tenacity, nor that approach to crystalline texture of some of the beds of the Catskill-mountain group near the Hudson river.

mountains and in the western part of the continent, are likewise associated with newer strata, or are of a very modern age.

In the comparatively slow accumulation over large areas along the course of the Laurentian and Appalachian mountains, the depression would be slowly accomplished, and, as I suppose, comparatively few extensive rents or fractures would be produced. These would be filled, as we find them in the dykes, with rarely overflows of the same matter. On the contrary, we may readily conceive that where very rapid accumulation has taken place over certain areas of limited extent, the crust below might give way, from the overload, and the whole be plunged into the semi-fluid mass beneath, causing it to overflow. Whether this reasoning be correct or otherwise, I believe that the overflows of trappean matter are always coincident with the rapid accumulation of sedimentary materials.

In the region of Lake Superior, the sandstone, of the age of the Potsdam sandstone, has accumulated to a degree unparalleled in any other known locality of that rock. In this region there are not only massive accumulations of trappean matter, but outflows which have spread over the strata during their deposition; the beds of stratified amygdaloid trap alternating with the shale and sandstone, often equalling or exceeding the sedimentary matter.

In the period of the New Red sandstone, we have evidences of very rapid sedimentary accumulations; and accompanying the same are large outflows of trappean matter, both in the form of dykes, interstratified and overflowing masses, such as are well described by Messrs. Jackson and Alger, and by Mr. Dawson in Nova-Scotia. In the Connecticut and Hudson-river valleys, whatever we may say of the age of the sandstone, we have evidence of its rapid accumulation; and though extending for a long distance in a line parallel to the Appalation chain, it has nowhere a great width, but always meets the conditions first stated, of a great and rapid accumulation within a narrow space.

Without having the data, at this time, for a comparison of other similar regions, I believe the law will hold true, that all great outbursts

of igneous matter are accompanied by formations of rapid accumulation.

Following the evidences from the oldest geological times, we find in the later periods a greater accumulation of trappean or volcanic products, which in many instances have added largely to the mass of the sedimentary deposits with which they are associated, or of themselves have produced extensive masses.

Volcanoes proper, and their products, are of modern date; and it has been shown by the observations of numerous geologists, that these phenomena are always associated with the tertiary or more modern geological formations. I believe that these phenomena have been produced in regions of great and rapid accumulation of other deposits, and can never occur except as the result of such conditions. These igneous outflows, therefore, I regard as produced by and dependent upon other agencies, and are but the manifestations of rapid accumulations of sedimentary matter.

It is thus at the termination of the series, and where may probably exist the entire sequence of formations, that we find the greatest exhibition of volcanic phenomena in any geological period.

Therefore it would appear that we have, in the slower accumulations, the highest mountain chains produced in the most recent geological periods; while the results of later accumulations, under other circumstances, have given us the stupendous volcanic phenomena which have been manifested from the earliest tertiary epochs.

In the present introduction to Volume III, it was not originally my intention to extend this discussion to formations beyond those which constitute a part of the great system, the fauna of which I have endeavored to illustrate in its sequence, and to some extent in its geographical distribution. I have, however, necessarily been drawn into the discussion of certain principles applicable to all geological formations of whatever period, and which are indeed elementary as well as fundamental to the science. Instead of stating these views simply as con-

In what I have stated, and in the conclusions drawn, I believe I have controverted no established fact or principle, beyond that of denying the influence of local elevating forces, and the intrusion of ancient or plutonic formations beneath the lines of mountain chains, as ordinarily understood and advocated. In this I believe I am only going back to the views which were long since entertained by geologists relative to mountain elevation. In other respects, the views I have advanced are the legitimate results of observation, and an extension in the application of laws well established and acknowledged in science.

The facts here adduced relative to the strata composing the Appalachian range and their extension to the west and southwest, are all capable of verification; and the deductions hence drawn seem to me perfectly legitimate. I believe, moreover, that this mountain chain, in its component parts, and in its mode of accumulation, and the process by which it has assumed its present position, does not differ materially from other mountain ranges.

The direction of any mountain chain, I would infer, corresponds with the original line of greatest accumulation, or that line along which the coarser and more abundant sediments were deposited. The changes consequent upon the accumulation of such a mass of sediments would, often at least, prevent the immediate deposition of another series of beds of consecutive age in the same direction. Neither is it probable that distinct ranges of mountains, though composed of sediments of the same age, would have a corresponding direction. The Rocky mountains, though perhaps fundamentally composed of deposits of the same age as the Appalachians, have had their materials derived from a different source, and distributed by a current having a different direction. Moreover the greater height of the Rocky mountains appears to be due to later deposits than those constituting the Appalachian range; and if we may credit all the facts stated and their verification by collections of fossils, the strata of newer age than the Coal measures, with the

limestones of that age, constitute a large part of the mass producing the altitude of that range of mountains*.

If it be true that original deposition or accumulation has given origin to mountain ranges, then, the greater that accumulation, the higher will be the mountain chain; and if, after the formation of the older strata along certain lines, there shall supervene conditions allowing the deposition of later formations above the older ones, we may, on the final elevation of the continent, have mountains of greater altitude composed of strata of successive ages. I can conceive, moreover, that under analogous circumstances, the direction of the later currents in the transportation of material may not always have coincided with that of the former ones; and we may have diverging or cross ranges of mountains with higher summits, where the greater accumulation or the combined accumulations from several sources have taken place.

It will not be easy to test this question immediately; so preoccupied are the minds of observers with other views respecting mountain elevation, and so numerous are the circumstances that may lead astray the best intentions of seeing correctly. It is not many years since the belt of country between the Hudson river and the Atlantic was regarded as one great Primary mass. Later observers began to yield a little, and contented themselves with a Primary axis; and now we have the evidence derived from fossils occurring at intervals over much of the area between the Hudson and the Connecticut rivers, as well as from the geological structure of the country, that these rocks all consist of strata lying between the base of the Silurian and the beginning of the Coal measures; while on the east of the Connecticut river, the crystal-

* See the Reports of NICOLLET, FREMONT; of EMORY, ABERT, COOKE and JOHNSTON*; of Captain STANSBURY, Captain MARCY, Dr. D. D. OWEN : Reports of Explorations and Surveys for a railroad route to the Pacific, MARCOU, BLAKE, NEWBERRY and others : EMORY's Report on the United States and Mexican Boundary Survey, Geology, etc., by the writer. Also, results derived from Explorations on the Upper Missouri in 1853, made under my direction, by F. B. MEEK and F. V. HAYDEN†. In addition to all these, may be cited the facts acquired by, or the results derived from, the observations of all the explorers of this mountain range.

* Ex. Doc. No. 41, Thirtieth Congress : Notes upon the Minerals and Fossils, etc., by Prof. J. W. BAILEY.

† A communication made by the writer to the American Association for the Advancement of Science, at the meeting of 1855. (Not printed.)

line rocks are, to a large extent at least, confessedly of the age of the Coal measures, and the anthracitic plumbago of Worcester (Massachusetts) is recognized as of the same age as the anthracite of Rhode-Island.

We may expect that changes equally great will yet take place in the opinions of geologists regarding other mountain ranges. It is now a long time since the supposed primary origin of the Alps has given place to more rational views, and all geologists admit that the summits of these mountains are composed of the more modern geological formations. If the fundamental rocks of the Alps are of palæozoic age, and the sequence has been continued, even with some interruptions, to the end of the Jurassic period or later, it is no wonder that there are high summits, for the accumulation must have been enormous; and if to the Liassic and Jurassic we add the Cretaceous and Tertiary, we may get mountains of the elevation of the Himalayas. For I hold that no mountains of this elevation can occur without the long continued accumulation of sediments; sediments, not simply marking this altitude, but vastly more, for there is doubtless as much of the mass below the level of the sea as above it. This view we find applicable to the Appalachians, and it must be a necessary condition of mountain elevation. Moreover, I believe it to be true, and a legitimate inference from the facts and generalizations already stated, that all mountains of great height will be found to embrace the newer geological formations in their mass*.

* In attributing mountain elevation to the action of subterraneous upheaving forces, no satisfactory explanation has been given to account for the much more powerful influence exerted in one country or along one line, than in another. It will not meet the inquiry to say that the former or earlier operations of this class were more powerful than the later; for the reverse is true. If we look at the oldest or Laurentian and Adirondack mountains, the greatest elevations are only about five thousand feet above tide water, while the palæozoic Appalachians are little more than six thousand; and we have very good evidence that the country occupied by these ranges was the earliest continental land. When we go westward to the Rocky mountains, we find higher elevations above tide water; but we also have newer formations, showing that the final elevation of that part of the country was accomplished at a later period than that of the eastern zone. Whether there may have been a previous elevation of this part of the country, and a second submergence, does not affect the inferences in the present case.

The facts which I have here brought together and presented, as I believe, in a new combination, and the principles enunciated as the results of my investigations upon the phenomena exhibited over a large area of country, may, I hope, aid in elucidating certain questions in geology, which have hitherto been surrounded with difficulties. After the brilliant discussions of the problem of the Appalachian chain by the brothers ROGERS, and other able geologists, and the masterly elucidation of their beautiful structure, there is certainly little left to be done in this regard; and I cannot hope to offer anything so full of interest. At the same time, it does not appear to me that in any of our discussions, sufficient importance has been given to the influence of this large accumulation of matter along the Appalachian zone; nor to the necessary and consequent effect of this accumulation. The deposition along current lines (or shore lines), and the spreading out and thinning of the same deposits on receding from this line, is all in accordance with the elementary teachings of geology. We know, moreover, from the nature of the principal limestone formations, and the presence of corals and other forms of ancient life in these rocks, that they could not have been accumulated in turbid waters, nor along lines where argillaceous and siliceous materials were being deposited. An entire or almost an entire cessation of these sediments must have taken place before calcareous matter could accumulate in large quantities along the same zones; but in these instances, where the amount of matter was insufficient, or the force of the current inadequate to transport these materials far beyond the great zone of deposit, there would be accumulated in the quiet waters the formations resulting from animal exuviæ; and here only could we expect to find coralline limestone and formations of similar character.

In order, therefore, to have a clear idea of any portion of country, it is necessary, in the first place, to take into consideration the mode and manner of the original distribution of the sediments constituting the series of formations; for on this must depend their ultimate character. The slow accumulations in one place, and the rapid accumulation in another place, which we know to be necessary conditions of geological deposition, must exert an influence, not alone on the character and topography of the country, but upon the nature of its rocks and its ultimate productions.

NOTES.

NOTE A.

In bringing forward the foregoing statement of facts, and what I regard as the legitimate inferences therefrom, I have not thought it necessary to controvert the prevailing opinions relative to the elevation of mountain chains.

The grand theory, so beautifully and completely elaborated by E. de Beaumont, and at the present time received by a large number of geologists, may still equally apply to the exposition of the systems of mountain chains : nor indeed does it appear necessary to do more than change the language of description regarding the process of elevation. If my views of accumulation and the results therefrom be correct, then the lines of mountain elevation of De Beaumont are simply lines of original accumulation, and the consequences I have shown to follow. The mountain systems remain the same as before : we simply offer a different explanation of their origin. When we shall have learned, what I now fully believe, that the ancient depositions along shore lines or current lines have produced accumulations which, through subsequent influences, have become the mountain chains, it will be seen that these chains may be as various in their direction as the ancient shore lines, or as the currents traversing the ancient oceans. In one case the explanation of their origin is from later action upon the earth's crust; in the other, the course of the chain and the source of the materials were predetermined and in operation long anterior to the existence of the mountains which they constitute, or the continents of which they form a part.

The original idea that the dislocations, fractures, or mountain elevations have taken place along the weaker lines of the earth's crust, is shown to be fallacious, from the accumulations known to exist, not only along the Appalachian chain, but also in the Rocky mountains and in other mountain chains. So far, therefore, as

NOTE C. — (See Page 70.)

This process of the subsidence of the sea-bottom when loaded by accumulating sediments, is clearly recognized by Herschel in his explanation of the rising of Scandinavia, which he says may be caused by the accumulation of sediments on the adjacent ocean bed; which, giving way beneath the pressure, will drive a portion of the yielding matter beneath the adjacent continent, thus causing the elevation.

This process of depression at one point and elevation at another by the yielding mass beneath, doubtless offers an explanation of many phenomena both of recent and more ancient geological times. I have shown in the preceding pages that the strata composing the Lower Helderberg group, and to a great extent the Oriskany sandstone also, follow a line parallel to the Appalachian chain, and do not extend far to the westward : at the same time it is shown that there had been a movement in the accumulated sediments of prior date, and these beds lie unconformably above the inclined beds of the Hudson-river rocks below. The depression of the accumulated matter along the axis of the Appalachians, displacing the yielding mass beneath, would cause an elevation or bulging of the ocean bed on the western side, which, at the distance of a hundred miles, might have risen so near to the surface as to prevent the accumulation of sediments; while the slope of gradually deepening waters towards the present mountain range would allow the formation of just such a set of strata as we now find, having their thickening edges towards the east, while they gradually thin out on the west.

NOTE D.

From the study of the palæzoic formations in the Appalachian chain, and their distribution over the great plateau of the West, we discover why it is quite impossible to have uniformity in the nature of the strata, or in the conditions of the surface. The conditions accompanying the transportation and deposition of the sediments which took place along the lines which now mark the mountain chain, were very different from the conditions attending the accumulation on either side. We see that the mountainous region is mountainous, not from the folded and plicated condition of the beds constituting the mass, but because of former accumulations of matter. The metamorphic condition is simply the result of the

If the quantity of siliceous and aluminous ingredients brought up by such springs were great, instead of being utterly insignificant, it might be contended that the mineral matter thus expelled implies simply the decomposition of ordinary subterranean rocks; but the prodigious excess of carbonate of lime over every other element must, in the course of time, cause the crust of the earth below to be almost entirely deprived of its calcareous constituents, while we know that the same action imparts to newer deposits, ever forming in seas and lakes, an excess of carbonate of lime. Calcareous matter is poured into these lakes and the ocean by a thousand springs and rivers; so that part of almost every new calcareous rock chemically precipitated, and of many reefs of shelly and coralline stone, must be derived from mineral matter subtracted by plutonic agency, and driven up by gas and steam from fused and heated rocks in the bowels of the earth.

Not only carbonate of lime, but also free carbonic acid gas is given off plentifully from the soil and crevices of rocks in regions of active and spent volcanoes, as near Naples and in Auvergne. By this process, fossil shells or corals may often lose their carbonic acid, and the residual lime may enter into the composition of augite, hornblende, garnet, and other hypogene minerals. That the removal of the calcareous matter of fossil shells is of frequent occurrence, is proved by the fact of such organic remains being often replaced by silex* or other minerals, and sometimes by the space once occupied by the fossil being left empty or only marked by a faint impression. We ought not indeed to marvel at the general absence of organic remains from the crystalline strata, when we bear in mind how often fossils are obliterated, wholly or in part, even in tertiary formations; how often vast masses of sandstone and shale, of different ages and thousands of feet thick, are devoid of fossils; how certain strata may first have been deprived of a portion of their fossils when they became semi-crystalline, or assumed the *transition* state of WERNER, and how the remaining portion may have been effaced when they were rendered metamorphic. Rocks of the last-mentioned class, moreover, have sometimes been exposed again and again to renewed plutonic action."

It appears to me that the facts I have adduced regarding the distribution of sedimentary materials, as exhibited in the eastern part of the United States, offer a clear and simple solution of this question. Indeed it only requires that we consider the origin and mode of distribution of the sediments and the accumulation of calcareous beds, which together form the crust of the globe, to discover the impossibility of having an equal or approximatingly equal amount of calcareous matter among the metamorphic rocks. It is only in the regions of great accumulations of transported sedimentary matter that the conditions of metamorphism exist, or at least operate on an extensive scale. The conditions under which these deposits were made, did not admit of large accumulations of calcareous matter; and I have shown that in relation to the Appalachians, the greater amount of

* [This happens quite as often in the non-metamorphic as in the metamorphic strata. H.]

This great limestone belt marks a period of cessation in the sedimentary accumulations, and may afford the means of subdividing these older crystalline formations. At the same time, its occurrence everywhere shows that no subsequent action has operated to remove any appreciable portion of the calcareous material.

It must always happen that in the temporary or permanent change in the direction of the transporting current, there will be calcareous accumulations of greater or less importance, which will ultimately become involved in the metamorphism of the mass. At the same time, if from any cause there should be a cessation of these deposits for any considerable period, then calcareous matter would be accumulated over that portion of the ocean bed before swept by the transporting current. Notwithstanding, however, all these exceptions, the proportion of calcareous matter in highly metamorphic regions must always be comparatively small.

Although when we consider the entire mass of rocks composing the Appalachian chain, the proportion of calcareous matter is small, there are nevertheless extensive and very important strata of limestone, furnishing everywhere the white and variegated marbles so well known and so extensively used for architectural and ornamental purposes. These strata appear to consist mainly of the Lower Silurian limestones, which, in the Chazy, Birdseye, Black-river and Trenton limestones, spread out far to the westward, and, though greatly attenuated, can be traced beyond the Mississippi river. Their united thickness in the east, though amounting to several hundred feet, is not altogether one-tenth of the thickness of the sedimentary deposits which immediately follow, and which, in variety of form and degrees of intermixture, produce the argillaceous and siliceous strata of the lower portions of the Appalachian chain. The limestone of the Niagara period, and a devonian limestone apparently of the age of the Upper Helderberg limestone, are recognized among the metamorphic strata of this mountain range; but these are inconspicuous and essentially insignificant when compared with the whole, constituting less than one-twentieth, and perhaps more nearly one-fortieth of the great metamorphic sedimentary mass with which they are associated*.

* I have not thought it necessary, in this notice, to enter into any discussion to prove the age of the sedimentary formations constituting the Appalachian chain. This I conceive has been established many years since, in Pennsylvania and Virginia, by the labors of the Professors Rogers and their assistants in the State Geological Surveys; in New-York and the adjacent parts of New-England, by the writer, and in Vermont by Professor Adams; while the investigations of Sir W. E. Logan, in the Canada Geological Survey, have given such admirable results as to leave nothing more to be desired. Later investigations, now in progress in Canada, Vermont and Massachusetts, not only cor-

Notwithstanding the extensive outcrops of all these calcareous strata in the Northern Appalachians, there are few extensive deposits of calcareous matter from springs, and far less than occur in the unaltered limestone districts. The thermal springs of the western slope in New-York, which evolve nitrogen, produce no mineral deposits of any kind.

The imperfect study of these metamorphic rocks which I was able to make, while engaged in other duties, during the years 1843, 1844 and 1845, enabled me to recognize among these deposits a certain order which appeared to me to be marked by the presence of characteristic minerals which had been segregated from the surrounding mass. These observations, combined with subsequent considerations of the subject, convinced me that much might be done in the recognition of metamorphic masses by the contained minerals; and that a proper study of these would reveal some means of identification of beds at distant points, analogous to the mode of distinguishing successive formations by their contained fossils. I have subsequently, on many occasions, advocated this view, in discussions before the American Association for the Advancement of Science, and I am convinced that something of this kind will yet grow out of the farther investigation of the metamorphic rocks and their contained minerals*.

In approaching the study of the metamorphic masses from the non-metamorphic rocks, or, as we might almost say, from the organic side, they impress the student very differently from the same rocks, if first studied in all their variety as mineral masses, and designated as they are by certain names which are either arbitrary or derived from the results of metamorphic action; for example, gneiss, mica slate, talcose slate, hornblende slate, calcareous mica slate, etc. etc.: names contrived to express the mineral condition of the rock, and the prevailing minerals of which it is composed.

The student from the unaltered rocks has been accustomed to see all the sedimentary strata presenting the aspect of fine shale or slate, or of sandstone and of

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roborate what was before claimed, but bring to light some facts which indicate a greater extension of the Devonian rocks to the westward than we have been accustomed to believe.

* Every observing student of one or two years' experience in the collection of minerals in the New-England States, well knows that he may trace a mica schist of peculiar but varying character from Connecticut through Central Massachusetts, and thence into Vermont and New-Hampshire, by the presence of staurotide and some other associated minerals, which mark with the same unerring certainty the geological relations of this rock, as the presence of *Pentamerus oblongus*, *P. galeatus*, *Spirifer niagarensis*, or *S. macropleura*, and their respectively associated fossils, do the relations of the several rocks in which they occur.

strata showing infinite gradations between the slate and sandstone; intermixtures and interlaminations of the one and the other, and all possible modifications of these two simple materials in the sedimentary deposits : the admixture of calcareous matter producing calcareous shale and calcareous sandstone, and giving a less or more calcareous character to all the intermediate varieties of these rocks, and finally the development of limestone. All these are familiar to him; and as he approaches the changed forms of these rocks, and sees the beginning of metamorphism, and the gradual development of the segregated and crystallized minerals, he still looks upon these rocks in the mass as strata of shale, sandstone, and the intermediate varieties of rock made by the mingling of these and the accession of calcareous matter. The fundamental rock still holds its place in the mind of the geologist, and the gradually assumed crystalline structure and the segregation of crystallized minerals does not make him forget the normal condition of the mass; and he knows that the occurrence of these minerals is due to chemical action, and that the original character of the beds has determined the kind of mineral which shall be developed when the mass is subjected to this influence, or placed in a condition to allow of free molecular motion. The metamorphism has only given combination and form to materials before existing in the rock : it has produced nothing new.

Since, in the unaltered condition of these strata, no two shales or sandstones or any intermediate gradations of these rocks, nor any two limestones in the sequence, preserve precisely the same characters; so is it impossible that we should have, in the metamorphic strata, any two sets of beds of precisely the same character or giving origin to the same minerals, with the same modifications of form, precise composition, etc. The difficulty of characterizing the metamorphic rocks by strict terms without qualification, is equally as great as among the unaltered rocks in designating all the gradations from shale or slate to sandstone, and all the modifications produced by a greater or less admixture of calcareous matter with the ever varying proportions of the other two.

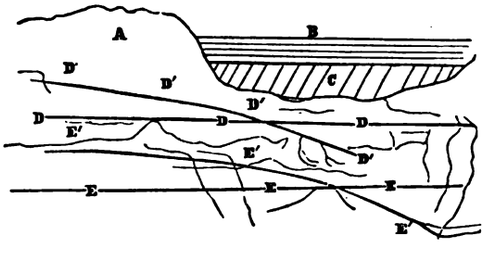
In the western flank of the Green mountain range, the great variety of schists designated as talcous, mica, gneissoid mica, hornblende and calcareous mica slates are all results of the metamorphism of Silurian strata, and, to a great extent, express the gradations which, a little farther west, are represented in the Utica slate, the Frankfort slate, the Pulaski shales and sandstones, and the upper sandstones and conglomerates of the Hudson-river group, together with the Medina sandstone and the strata of the Clinton group and associated calcareous beds, including also some part of the Niagara group. At the same time it has been clearly shown, from investigations in the Canada Geological Survey, that the intercalated, irregular, and interrupted beds of magnesian limestone in the upper part of the Hudson-river group become the serpentines of this mountain range.

NOTE E.

I HAVE already alluded to the explanation, given by Sir JOHN HERSCHEL, of the process by which continental areas may be elevated from the accumulation of deposits upon the ocean bed. I have seen this explanation only as published in the appendix to BABBAGE's Ninth Bridgwater Treatise, as an extract of a letter from this philosopher to Sir CHARLES LYELL. Since this and another letter to LYELL, and one to Sir R. I. MURCHISON, contain many suggestions which seem to me as offering support to the views I have advanced, I have made some extracts which follow :

After discussing the question of the rise of the isothermal surfaces beneath the earth's crust from the deposition of new matter on the bed of the ocean, a view which appears to have originated in the minds of BABBAGE and HERSCHEL quite independently of any knowledge of each other's conclusions, he goes on to speak as follows (alluding to LYELL's Principles of Geology) :

" According to the general tenor of your book, we may conclude that the greatest transfer of material to the bottom of the ocean is produced at the coast line by the action of the sea, and that the quantity carried down by rivers from the surface of continents is comparatively trifling. While, therefore, the greatest local accumulation of pressure is in the central area of deep seas, the *greatest local relief* takes place along the abraded coast lines. Here, then, in this view, should occur the chief volcanic vents. If the view I have taken of the motionless state of the interior of the earth be correct, there appears no reason why any such influx of heat should take place under an existing continent (say Scandinavia) as to heat incumbent rocks (whose bases retain their level) 5 or 600° Fahrenheit for many miles in thickness (Princ. of Geology, Vol. ii, p. 384 : 4th edition). LAPLACE's idea of the elevation of surfaces due to columnar expansion (which you attribute, in a note, to BABBAGE), is, in this view, inadequate to explain the rise of Scandinavia or of the Andes, &c. But, in the variation of local pressure due to the transfer of matter by the sea, on the bed of an ocean imperfectly and unequally supported, it seems to me an adequate cause may be found. Let A be Scandinavia, B the adjacent ocean (the North Sea), C a vast deposite newly laid on the original bed of the ocean, E E E a semifluid or mixed mass on which D D D reposes. What will be the effect of the enormous weight thus added to the bed D D D (rock being heavier than sea)? Of course, to depress D under it, and to force it down into the yielding mass E, a portion of which will be driven laterally under the continent A and upheave it. Lay a weight on a surface of soft clay : you depress it below, and raise it around the weight. If the surface of the clay be dry and hard, it will crack in the change of figure."



Now it seems to me that the proposition here stated, and the result which follows, tend to sustain the views I have advanced.

If this deposit C becomes so great as to disturb the equilibrium of pressure, and the effects upon the yielding mass below are such as to displace a portion of the same, then the strata which were originally deposited in a horizontal position must become curved. The area of deposit could not have acquired an equal accumulation, and there would be little or no depression towards the thinning margins. Then if the accumulation should go on to many thousands of feet in thickness, and the ocean bed be depressed accordingly, we should have a greater deflection of the strata from the original horizontal position; and, as I conceive, this depression must be accompanied by folding or plication, unless, as HERSCHEL suggests, the support may give way, and the mass be plunged into the fluid beneath, which would cause a rush of this matter upwards. This condition, however, as I believe, happens only when the accumulation is very rapid, and probably often not widely extended.

I am not quite able to agree that the subversion of the equilibrium of temperature is more important (in the outset at least) than the subversion of the equilibrium of pressure, though I conceive that its ultimate effects are more important and more permanent; since, as he says, every continent depressed has a tendency to rise again, and, as I understand, this results in a great measure from a restoration of the equilibrium of temperature. It is this ultimate rising of continental masses, that I contend for, in opposition to special elevatory movement along the lines of mountain chains.

In a letter to Sir RODERICK MURCHISON, following the one above cited, Sir JOHN HERSCHEL discusses this subject still farther, showing conclusively that the deposition of sediments, subverting the equilibrium of temperature and of pressure, produces the result, as a natural and necessary consequence, which even at this day is too often attributed to excessive or abnormal influence of the heated or fused interior mass. "*Let strata be deposited*," he says, and we have all the required condition for producing metamorphic rocks.

Reasoning from a different point, and with a different class of facts under consideration, I have arrived at the conclusions before given; and, farther, that without great accumulations of strata (perhaps a legitimate deduction also from the arguments of HERSCHEL), no important or extensive metamorphism can take place.

In the preceding pages, I have often used the term *current lines*, or *accumulation along the current lines*. I might, more properly in most cases, have used the term *coast lines* or *shore lines*; these being doubtless the zones of great accumulation, and in this view we may have had a coast line nearly parallel and coextensive with the Appalachian chain. This fact, however, if ascertained, would not conflict with the facts or arguments I have adduced.

PALÆONTOLOGY OF NEW-YORK.

ROCKS OF THE HELDERBERG MOUNTAINS.

A SECTION of the strata comprising the Helderberg mountains proper in Albany county, and the same in Schoharie and the adjoining counties, presents the following groups and beds in the descending order :

	Hamilton group.
UPPER HELDERBERG GROUP :	Corniferous limestone.
	Onondaga limestone.
	Schoharie grit.
	Cauda-galli grit.
	Oriskany sandstone.
LOWER HELDERBERG GROUP :	Upper Pentamerus limestone.
	Encrinal limestone.
	Delthyris shaly limestone.
	Pentamerus limestone.
	Tentaculite or Water limestone.
	Argillaceous and Magnesian limestones of the Onondaga-salt group.
	Coralline or Niagara limestone*.

The fossils described in the present volume are from the limestones constituting the Lower Helderberg group, and from the Oriskany sandstone. Although convenient for local reference, I have found it impossible to recognize the subdivisions, instituted in the Geological Reports, at any great distance from the Helderberg mountains; while the group, as a whole, has a wide geographical distribution from northeast to southwest, characterized by numerous fossils.

* These beds together are rarely more than twenty-five feet in thickness, and produce no conspicuous feature in the geology or topography of this region.

I have therefore adopted the name of the locality where the beds are best developed, for designating the entire group. The fossils are in some degree restricted in their vertical range, where the physical characters of the strata present the distinctive varieties peculiar to the subdivisions. Where, however, lithological character is more uniform throughout, the fossils are less restricted; and it would be impossible to indicate limits to any of the species below the Upper Pentamerus beds. This terminal member of the group does not everywhere exist; but where occurring, it is marked by a species of Pentamerus having nearly the same form as *P. galeatus*, but always smooth, and possessing other characters by which it can readily be distinguished from that species. Associated with this *Pentamerus* are several species of ***Rhynchonella***, equally restricted in their vertical range; as well as a single ***Spirifer***, of which only one specimen has been found, in a lower bed. A few species at the base of the formation are likewise very much restricted in their vertical range, as far as the formation has been examined.

The Oriskany sandstone rests directly upon the upper member of the Lower Helderberg group. This rock is usually highly fossiliferous, being often composed of a mass of shells closely packed together. It is sometimes, however, quite non-fossiliferous, and consists of a thin band of dark-colored, compact, siliceous rock, which graduates into the arenaceous shaly mass above.

Although usually very distinct from the limestones below, there are nevertheless localities where a passage occurs between the two rocks; and in such instances, some of the fossils, usually restricted to the lower beds, pass into those above. Instances of this kind occur in Maryland; and from the collections of the Canada Survey, by Sir WILLIAM E. LOGAN, we are prepared to find in some parts of the continent an intimate blending of these formations.

In this volume, the fossils of the Lower Helderberg group, and those of the Oriskany sandstone, are arranged as fossils from separate and successive groups, which is fully justified by their physical condition in the State of New-York.

CRINOIDEÆ AND CYSTIDEÆ OF THE LOWER HELDERBERG LIMESTONES AND ORISKANY SANDSTONE*.

Upon the commencement of the engraving for the third volume of the Palæontology of New-York, not more than five species of Crinoideæ and Cystideæ were known to occur in these rocks. The great numbers of columns and other fragments of these fossils in certain localities induced a belief that a greater number of species would eventually be found; and a much larger number of plates was assigned for the illustration of these fossils, than would have been required for those at that time known.

As the collections have progressed, new species have at intervals been discovered, and also better specimens of those previously known; so that although the material for the illustration of these families of fossils was formerly so meagre, we have now the means of presenting an interesting group. The species and individuals are far from being as numerous as those of the Niagara group; and while a single crinoid and one cystidean only are of the same type, the remainder present a much wider departure from those, than might have been anticipated from the similarity of the sediments, and the affinities of the brachiopoda, corals, and bryozoa of the two periods.

Notwithstanding these additions of species in the limestones, there still remain numerous fragments of columns, arms, etc., which are yet unidentified. Some fortunate localities will hereafter, probably, furnish as many more species as we now possess; and, judging from the limited range of most of the known species, we may anticipate a greatly increased number, when the formation shall have been thoroughly studied from its best known localities in New-York, along its line of outcrop to the southwest as far as Middle Tennessee.

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* Corals and Bryozoa of the Lower Helderberg Limestones. The conspicuous Corals of this period consist of *Streptelasma*, *Zaphrentis*, *Favosites*, *Stromatopora*, *Chætetes*, etc.; while the Bryozoans present numerous forms of *Fenestella*, *Trematopora*, *Callopora*, etc., which closely resemble Niagara species. Conceiving that it would be more satisfactory to publish the Corals and Bryozoa of this and the succeeding groups of strata altogether, I have made arrangements to give the descriptions and figures of all these in the last volume of the Palæontology of New-York.

The formations of this age, which have been identified in Canada as far to the northeast as Gaspe, have not yet furnished determinable forms of Crinoideæ, though fragments of them are of common occurrence in the strata. In the present state of our knowledge, however, it is impossible to arrive at any general conclusions regarding the probable number and distribution of the Crinoideæ and Cystideæ of this period.

We have heretofore regarded the Niagara period in America, as the Wenlock period is in Great Britain, the most prolific in these forms of fossil remains; but we have more recently learned that a single locality of Lower Silurian limestones in Canada has furnished more species of Crinoideæ and Cystideæ than have heretofore been found in all Lower and Upper Silurian strata together. The known habits of these animals, and the very limited geographical range of most of the species, are sufficient to warn us against conclusions based upon the very partial explorations yet made in the strata of this period.

The Oriskany sandstone, within the limits of the State of New-York, has not furnished any well-defined species of Crinoideæ or Cystideæ; but in tracing this rock to the southwest along the Appalachian chain, it becomes developed in much greater degree than in New-York, and contains numerous species of fossils not known in this State. Among these are several species of crinoids, of genera similar to those of the limestones below; showing, by these fossils as well as by the Brachiopoda and Gasteropoda, the intimate zoological relations of the two groups of strata.

Among the peculiar forms which mark both the limestones and the sandstone, the *Edriocrinus* is perhaps the most remarkable : a crinoid which is sessile in its young state, and firmly attached to other bodies by the base of its cup, but becomes free as it advances, and gradually loses all evidence of a cicatrix; the base becoming rounded and smooth, or, very rarely, preserving a depression or pit near the centre, which marks the original point of attachment.

There is likewise another somewhat similar form with solid base, which preserves the marks of attachment of the column; but all the specimens, thus far discovered, have afforded no clue to the structure of the upper

part of the body. It may yet be found that these two forms are so nearly identical in structure as to constitute one genus; some species being sessile in the young state, and free as they approach maturity, while others are provided with a column.

The Genus *Platycrinus* occurs in this period for the first time in American Silurian strata; and though this genus is very prolific in the Carboniferous period, I am not aware at present of its occurrence at any point between the Lower Helderberg limestones and the Carboniferous limestone.

The species of the Genus *Mariacrinus* compose by far the most conspicuous forms among the Crinoideans, both of the limestones and the succeeding sandstone. Two species of *Homocrinus* and a cystidean (*Lepocrinus*, CONRAD; *Apiocystites*, FORBES) are of generic types identical with those of the Niagara period.

The following lists of genera of Crinoideæ and Cystideæ, known in the Clinton and Niagara groups, and in the Lower Helderberg group and Oriskany sandstone, afford the means of comparison of these fossils in the different periods.

CRINOIDEÆ AND CYSTIDEÆ of the Clinton and Niagara groups.		CRINOIDEÆ AND CYSTIDEÆ of the Lower Helderberg group and Oriskany sandstone.	
CLOSTEROCRINUS.....	1 sp.		
GLYPTOCRINUS [?]....	1		
HOMOCRINUS	2	HOMOCRINUS	1 sp.
GLYPTASTER	1	MARIACRINUS	8
THYSANOCRINUS	4	PLATYCRINUS	4
DENDROCRINUS	1		
ICHTHYOCRINUS.....	1+1?	ASPIDOCRINUS.....	2
LYRIOCRINUS	1	EDRIOCRINUS	2
LECANOCRINUS	4	BRACHIOCRINUS	1
SACCOCRINUS	1	CORONOCRINUS	1
MACROSTYLOCRINUS ..	1		
EUCALYPTOCRINUS	3		
STEPHANOCRINUS	2		
CARYOCRINUS	1		
MELOCRINUS	1		
HETEROCYSTITES.....	1	ANOMALOCYSTITES	1
CALLOCYSTITES	1	SPHÆROCYSTITES	1
APIOCYSTITES	1	APIOCYSTITES (= LEPADOCRINUS),	1
HEMICYSTITES	1		
PALÆASTER.....	1	PROTASTER?	1

re are, besides these, several species in both periods, which have thus far been determined only gments of columns, etc., and which are not included in the above lists.

Genus Homocrinus.

Palæontology of New-York, Vol. ii, p. 185.

The differences indicated between this genus and *Poteriocrinus* are constant in all the Silurian species examined; while the general habits of the animals, form of body, etc. are in all respects similar to the carboniferous forms of *Poteriocrinus*.

The generic description of the latter genus, having been framed for the Carboniferous species, would require a modifiation of the terms to include the Silurian species which I have indicated by the name of *Homocrinus*, and which appear sufficiently distinct to constitute a separate genus. In the present state of our knowledge, there is about the same degree of difference between the species of *Homocrinus* and those of *Poteriocrinus*, as exists between some species of the latter genus and those of *Cyathocrinus*.

Homocrinus scoparius (n. s.).

Plate I. Fig. 1.

Body elongate-conical, subpentagonal above; base comparatively large. Surface granulate or granulate-striate. Basal plates five, pentagonal, longer than wide, cuneiform above. Subradial or costal plates longer than wide, three hexagonal, the other two heptagonal, truncate above, and supporting on the upper lateral margins a small intercalated quadrangular anal plate. First radial or scapular plates five, pentagonal, wider than long; four resting upon the upper lateral margins of the contiguous subradial plates; the fifth resting upon the subradial plate on one side, and upon the intercalated anal plate on the other: its vertical side adjoins the second anal plate, and the upper lefthand angle is truncated by the third anal plate, giving it an irregular hexagonal form with one extremely short side. The succeeding radial plates, to the number of three or four below the first bifurcating plate, are quadrangular: first bifurcations equilateral.

ARMS long, slender, with seven or eight unequal bifurcations, with five to eight plates between each bifurcation.

PROBOSCIS strong, elongated, more than half as long as the arms, composed at the base of some larger plates, and above of small hexagonal plates: plates of the summit spiniferous.

COLUMN long, slender, consisting of irregularly alternating larger and smaller joints (frequently every fourth one larger), round below, and becoming obtusely pentagonal and enlarged above; the thicker joints subnodose. Canal small, round.

The entire width of the body of this beautiful little species, flattened as it usually occurs, rarely exceeds an eighth of an inch, and the height to the summit of the first three ranges of plates is scarcely greater than the width. The arms are extremely elongated and slender, and bifurcate regularly and equally on the fourth or fifth plate above the first radial; and above that point they present numerous unequal bifurcations, which continue almost to their extremities. The length from the base of the cup to the terminations of the arms varies from one inch to an inch and a quarter.

The column is often very long, proceeding in clusters from a mass of slender rootlets; and often, throughout its whole length, furnished with delicate lateral branchlets from the larger joints. In many of the separated columns, and in some which are still attached to the body, these branchlets are frequently not preserved. The surfaces of specimens often exhibit groups of the bodies with more or less of the column attached, and apparently in the same relations which they occupied while living.

Fig. 1. An individual showing the anal side, and the proboscis entire. The extremities are broken off on a line with the summit of the proboscis.

Fig. 2. An individual preserving the arms in part, with the proboscis removed.

Fig. 3. A specimen of limestone with several individuals in different states of preservation.

Fig. 4. A group exhibiting the mode of growth.

Fig. 5. A fragment of a column somewhat larger than usual.

Fig. 5 a. Enlargement of a portion of the column, showing the gradual approach to a pentagonal form.

Fig. 6. Enlargement of a portion of an arm, showing the mode of bifurcation, etc.

Fig. 7. Enlargement of a radial plate, showing the granulate surface.

Fig. 8. Enlargement of an individual, showing the structure of the body, arms and proboscis.

Fig. 9. Diagram showing the structure of the body and arms to the first bifurcation.

Geological position and locality. In the Tentaculite limestone at the Helderberg and Schoharie; also in some thinly laminated or slaty layers in the Pentamerus limestone at Schoharie and at Wheelock's hill, Litchfield, Herkimer county.

GENUS MARIACRINUS (n. g.).

Astrocrinites, CONRAD in Catalogue, Ann. Geol. Rep. of 1840 and 1841.
Not *Astrocrinites* of CUMBERLAND, 1839.
Not *Astrocrinites* of AUSTIN, 1843.
Not *Asterocrinus* of MUNSTER, 1831.

BASAL or pelvic plates four. Radial plates three in five series (3×5). Interradial plates three or more. Anal plates numerous. Brachial plates two resting on each third radial; beyond this point, the structure differs in different species. Surface of plates marked by elevated radiating striæ or ridges which are more or less prominent, or by nodes or short spines.

ARMS varying in structure in different species.

The species constituting the type of this genus is the largest and finest known crinoid in the Silurian System. Several other species of the genus are among the most beautiful and interesting forms of all the Silurian and Devonian crinoids. So far as known at present, this genus begins its existence in the Lower Helderberg group, and terminates in the Oriskany sandstone; giving at least six well characterized species, besides separate plates and columns which indicate the existence of several other forms.

This genus, in some of its forms, bears a general resemblance to *Glyptocrinus*, but the number of basal plates is constantly different; and though there are many modifications in the mode of bifurcation of the arms, the species of this genus differ essentially from any species of *Glyptocrinus* known to me.

The generic name *Astrocrinites* was used by Mr. CONRAD in his Reports of 1840 and 1841, but it is unaccompanied by any description; and though we may suppose it to have been a generic name proposed by himself as new, we are not so informed. Mr. MATHER, in his Geological Report of the First District, 1843, uses the name of *Astrocrinites pachydactylus* from the Report of Mr. CONRAD for 1841. I am not aware that any generic description of this fossil was ever published; and since the name *Astrocrinites* was preoccupied, and has subsequently been used by AUSTIN for a very different form, and at the same time is so similar to the name *Asterocrinus* of MUNSTER, 1831, that it cannot be used with propriety or without creating some confusion. For these reasons, I am induced to adopt another designation, although the mere use of the name in a published catalogue could not, under any circumstances, entitle the genus to a place in the system.

Mariacrinus nobilissimus (n. s.).

PLATE II. FIG. 1 – 4; and PLATE II A. FIG. 1.

BODY large, obconical below, becoming obtusely pentagonal above by the prominence at the base of the arms. Plates with obscure radiating ridges, which become conspicuous near the sutures. Surface finely granulose. Basal plates four, wider than long; three pentagonal, and one hexagonal and truncated above; the hexagonal basal plate anterior. First radial plates about as long as wide; four heptagonal, the anterior one hexagonal. Second radial plates sometimes longer than wide; four heptagonal and one hexagonal. Third radial plates about as wide as long; four heptagonal (?) and one octagonal. Intermediate plates large; four on each side of the four regular sides. Anal plates, or interradial plates upon the anal or irregular side, nine. Brachial plates two resting on each third radial, and each of these succeeded by two others which rest successively upon each other, with an intercalated single range of three or four small plates between. The third brachial plate on each side supports upon its upper edge a double set of plates, the outer ones of which on each side support the auxiliary arms, while the inner ones support the plates forming the centre or principal arm in direct succession, and its subordinate branches.

ARMS composed of double series of alternating plates, which are broader than long, slightly interlocking at their inner margins, producing a slight groove along the centre of the arm. Every fourth or fifth plate on each side becomes thickened on its outer margin, and obliquely truncated, giving origin to the lateral branches or armlets. The entire arm thus consists of its own articulations proper, and supports a series of lateral branches to the number of more than thirty on each side. The armlets or fingers are gradually tapering, nearly round, and composed of double series of alternating plates much broader than long, and closely interlocking at their wedgeshaped inner margins. Each one of these plates supports a tentacle on its outer margin, giving a double

row of tentacula along the fingers. Tentacula round, jointed; articulations nearly twice as long as broad : each articulation, from near its centre on the inner side, giving origin to a secondary round jointed tentacle, producing in this manner a first and second series of tentacles. Interbrachial plates seven or eight or more below the base of the proboscis, on each of the four regular sides.

COLUMN round, consisting of joints of nearly equal thickness, becoming thinner towards the body. Canal small.

This magnificent species of crinoid differs from several smaller forms of the genus in the smoother plates, which show some remains of obtuse radiating ridges towards their margins in some of the higher plates of the body; while the lower plates are essentially smooth, or with no ornament beyond the fine granulose surface. The structure of the brachial portion is remarkable in presenting an auxiliary arm on each side of the base of the principal arm, and which proceed from the lower brachial plates, and have essentially an origin independent of the central arm.

A remarkable feature of this and other species of the genus is that the main arms give origin to armlets (or fingers, in the nomenclature of MILLER), which bear the tentacula; while the joints of the main arms do not appear to bear tentacula, as far as can be observed.

In all the individuals of this species which have been seen, the extremities of the arms are broken off, and the entire length and expansion are not known. In one specimen, thirty armlets can be distinctly counted on each side; and from the size of the arm where broken off, it is probable that five or six, or perhaps ten more, may have existed.

The proboscis is only partially shown in a single specimen : its full length is unknown. The column in the small fragment attached to the specimen, Plate II, is composed of thin joints; while the fragment lying on the specimen, Plate II A, and other fragments of columns supposed to belong to this species, are composed of thicker joints. Judging both from the numerous fragments of columns found with this species, and from the known length of the column in another species, this crinoid was doubtless furnished with a long and strong column.

PLATE II.

Fig. 1. An individual nearly entire, showing a few joints of the column, the plates of the body, the arms and appendages.

Fig. 2. Enlargement of a portion of one of the arms and armlets.

Fig. 3 & 4. Enlargement of a portion of one of the armlets, and of one of the first series of tentacula, showing the character and arrangement of the second tentacula.

PLATE II A.

Fig. 1. A large individual, showing the anal or irregular side of the specimen, with numerous anal or interbrachial plates, the base of the proboscis, arms, etc. The upper part of the proboscis is covered by adhering stony matter.

Geological position and locality. In the thin shaly intercalated layers of the Pentamerus limestone : Wheelock's hill, Litchfield, Herkimer county.

Mariacrinus pachydactylus.

PLATE III. FIG. 1 – 4 A.

Actinocrinites polydactylus, Schenectada Reflector, 1835.
Astrocrinites pachydactylus, CONRAD in Catalogue, Ann. Rep. on Pal. N. York, 1841, p. 34.
Astrocrinites pachydactylus, MATHER, Geol. Report 1843, p. 246.

BODY broadly turbinate or subhemispherical (the form presented depending much on the degree of pressure it has sustained in the rock). Surface ornamented by strong radiating ridges from the centre of the plates, which, combining, give the whole a reticulate aspect, and each plate a star-like appearance : this character extends not only to the plates of the body, but to the brachial plates, and beyond the bases of the auxiliary arms. Basal plates wider than long, with prominent ridges extending to the upper edges, and a thickened lower margin. First radial or first costal plates as wide as long, four heptagonal and one hexagonal, marked with strong rays near the margin, and a strong ridge through the length of the plate in the direction of the arms. Second radial plates heptagonal, as long as wide, smaller than the first radials, and marked in the same manner. Third radial plates smaller than the second; three of them heptagonal, the others probably of the same form. Interradial plates small, strongly angulated upon the surface. Brachial plates heptagonal, two upon each third radial, and each succeeded by two other plates, which are slightly divergent and admit between them a row of smaller plates : again bifurcating upon the third brachial plate, the outer plate on each side gives origin to the auxiliary arm, and the two inner ones converge over the intercalated range of smaller plates, giving origin in direct line to the double series of plates which compose the main arm.

ARMS corresponding in structure to those of the preceding species; the plates slightly interlocking along the centre, and rectangular on their outer margins. Armlets opposite and originating at every fifth, sixth, or seventh plate of the arm, composed of a double series of wedgeform plates. Tentacula originating on the outer edges of the plates of the armlets : joints of tentacula nearly twice as long as wide. Secondary tentacula unknown.

COLUMN very long; consisting, near the body, of alternating large and small joints (the larger being the thicker ones); and farther from the body, of several thin joints between the thick ones, and sometimes presenting little difference in the thickness or diameter of the articulations.

The conspicuous differences between the preceding and this species are the strongly ridged plates of the latter, while in the other they are but inconspicuously marked in the same manner. The first radial plates of *M. nobilissimus* are proportionally longer than in this species, and the armlets are more closely arranged ; also the column attached to the base consists of numerous thin plates, while in this species the first joints below the base are thicker, with a very thin and scarcely conspicuous one alternating. Of the present species, some ten or more individuals, in various states of preservation, have been seen, and these are all of nearly the same size. Three specimens of *M. nobilissimus* have been found, each one having about the same dimensions as those figured.

Specimens of this species were found at Schoharie some thirty years since; and the first published notice appeared in the Schenectada Reflector newspaper in 1835, where the specimen fig. 1 of Plate III was figured and designated under the name of *Actinocrinus polydactylus*. In the same year, in an article in SILLIMAN'S American Journal of Science (Vol. XXVII, p. 363), this crinoid is referred to as the "*Stagshorn encrinite*." Subsequently, in 1840, Mr. CONRAD noticed this fossil as *Astrocrinites*, and in 1841 as *Astrocrinites pachydactylus*. In 1843, Mr. MATHER published a figure of the specimen, fig. 2, Plate III, from the Cabinet of Union College, under the same name. No description of genus or species has ever been published, so far as I am aware. The generic name *Astrocrinites* cannot be retained, for reasons given under generic synonymy; and in adopting a new generic designation, I have retained the specific name of *pachydactylus*, that name having appeared in the Annual Reports on the Geology of New-York and in the Final Report of Mr. MATHER : and the reference of this fossil to a described species *Actinocrinus polydactylus* in the Schenectada newspaper cannot impose the adoption of that specific name, as it might have done had the publication been made in a scientific journal.

These fossils have become extremely rare, no specimens having been discovered in many years past.

Fig. 1. An individual preserving the body and greater portion of the arms, with several inches of the column.

Fig. 2. The body and lower part of the arms, showing the surface characters in a good degreè of preservation.

Fig. 3. A specimen with arms, armlets, and tentacula nearly entire.

Fig. 4. Diagram illustrating the structure of the body and one arm to the second bifurcation of the brachial plates.

Fig. 4 a. Enlargement of a portion of an arm, showing the arrangement of plates and origin of armlets.

Geological position and locality. In some shaly layers near the base of the Pentamerus limestone of the Lower Helderberg group, Schoharie.

Mariacrinus paucidactylus (n. s.).

PLATE III. FIG. 5.

BODY somewhat obconical, very gradually enlarging above. Surface of plates strongly marked with radiating ridges. Basal plates unknown. First, second, and third radial plates longer than wide. First interradial plate longer than wide; the succeeding ones about as long as wide. Brachial plates as in *M. pachydactylus*.

ARMS slender, composed of a double series of slightly interlocking plates, with the armlets originating at every seventh, eighth, or ninth plate. Tentacula obscure.

COLUMN unknown.

The structure of the body in this species corresponds with the preceding species of this genus; the plates being marked as strongly as in *M. pachydactylus*, while their shape is different, giving the body a more elongate form.

The specimen is imperfect at the base of the arms, but it appears to be destitute of the auxiliary arms which mark the two preceding species. The arms are more slender, and the armlets are conspicuously more distant than in either of the others. These characters serve to distinguish it from all the associated species yet known.

Fig. 5. A specimen preserving the body above the basal plates, and a portion of several of the arms and armlets.

Geological position and locality. In the shaly layers of the Pentamerus limestone of the Lower Helderberg group, associated with *Mariacrinus nobilissimus* : Jerusalem hill, Litchfield, Herkimer county.

Mariacrinus plumosus (n. s.).

PLATE III. FIG. 6 – 11.

BODY small, obconic or turbinate : surface ornamented by strong radiating ridges proceeding from the centre of the plates. Basal plates about as long as wide. First radial plates a little longer than wide : second and third radials scarcely longer than wide. Interradial plates one below, succeeded by three ranges of two each. Radial and interradial plates strongly marked by radiating ridges. Brachial plates two at the base, which give origin to two ranges in direct line of three plates each and an intercalated plate, which rests upon the contiguous sloping edges of the two outer lower brachial plates; and above this, two ranges of two small plates each, precisely as in the interradial plates. From the summit of these originate four arms, composed of subcuneiform plates with lateral tentacles originating from the thicker sides. Tentacula near the base of each outer arm of the four, originating on every second plate, and sometimes an interval of two plates without tentacles; while on the two inner arms there appear to be no tentacles till about the eighth joint. Tentacula round, gradually tapering : joints short.

COLUMN round, comparatively large; consisting, near the base of the body, of nearly equal joints.

This species, in the aspect and structure of the body, ornamenting of surface, etc. scarcely differs, except in size, from *M. pachydactylus*. The arrangement of the brachial joints, and the character of the arms, are most conspicuously distinct. The first bifurcation of the brachial plates is, however, the same; but at the second bifurcation, the lateral brachial plates sustain the outer arms, which correspond to the auxiliary arms in the preceding species; while the upper ones of the central range, together with the inner oblique edges of the outer ones, sustain two small plates which give origin to the central pair of arms, corresponding to the main arm of the preceding species, but which is here reduced to the condition and structure of two of the armlets, and furnished in like manner with tentacula. The character of the species is thus most remarkably changed, by a modification of the brachial arrangements, reducing the whole number of these appendages to four from each ray, or twenty altogether; while in *M. nobilissimus* there are more than sixty from each ray, and more than three hundred altogether.

There are sometimes variations in the arrangement of the brachial plates, in which the intercalated or central range of plates above the first bifurcation consists of one plate below, succeeded by two ranges of two each, and two in single series above; and sometimes of a single range of three plates, one above the other. It is probable, however, that the number and arrangement of these small plates are not constant.

The arms of this species of *Mariacrinus* are so nearly like those of the associated species of *Platycrinus*, that in detached fragments they may readily be mistaken for the same.

Fig. 6. A small individual preserving the body and arms nearly entire, with a small portion of the column.

Fig. 7. A larger individual.

Fig. 8. Enlargement of the body of fig. 6.

Fig. 9. Enlargement of the arm-joints and tentacula.

Fig. 10. Enlargement of the rays and base of the arm-joints.

Fig. 11. Diagram showing the structure of the body and arrangement of the brachial plates.

Geological position and locality. In the shaly layers of the Pentamerus limestone, associated with the preceding species: Wheelock's hill, Litchfield, Herkimer county.

Mariacrinus macropetalus (n. s.).

PLATE III A. FIG. 1 & 10, 11, 12; ALSO PLATE III B. FIG. 1 & 2.

BODY large, hemispheric. Basal plates very wide and short. First radial plates much wider than high, four heptagonal and one hexagonal. Second radial plates pentagonal (?): third radial, pentagonal; all wider than high. Brachial plates large; lower ones hexagonal; second series pentagonal. Interradial plates one, large, nine- or ten-sided, succeeded by two smaller pentagonal plates.

ARMS unknown.

COLUMN large, round, deeply inserted into the base of the body.

The specimen described consists of the base and a portion of two series of the radial plates, and one series of interradial plates. The general structure, as far as visible, is so much like other species of this genus, that I have little hesitation in referring it to the same. The diameter of the base and size of the plates are about twice as great as in *M. nobilissimus;* and the entire body and arms, of the same general character as in that species, could scarcely have been less than nine or ten inches.

Associated with this species in the same rock are numerous fragments of large columns, roots, etc., which I have referred to this species, both from their analogy in size, and for the reason that there are no other large columns in the same rock, and indeed scarcely any crinoidal remains beyond these, which are likewise unknown in any of the beds below the Upper Pentamerus limestone.

PLATE III A.

Fig. 1. A specimen showing the base and a portion of the body.

Fig. 10. A fragment of the column with the rootlets attached.

Fig. 11. A fragment of the column with the rootlets worn off.

Fig. 12. Another fragment with rootlets attached.

Fig. 8 & 9 are detached rootlets of the same species, and should be reversed in position upon the plate.

PLATE III B.

Fig. 1 & 2. Roots and rootlets of the same species.

Geological position and locality. In the Upper Pentamerus beds of the Lower Helderberg group : Schoharie and the Helderberg.

Mariacrinus stoloniferus (n. s.).

PLATE III A. FIG. 2; AND PLATE III B. FIG. 3 – 7.

BODY and arms unknown.

COLUMN round; composed of thin, nearly equal joints, with numerous lateral radicles or branches, proceeding mainly from one side. Articulating surfaces finely striated. Canal round, large, often excentric.

From the general similarity of these columns to others of the Genus *Mariacrinus*, I have referred them to the same. Their mode of occurrence indicates that they have grown irregularly over the surface; bending according to its inequalities, and sending off, principally upon one side, numerous small rootlets or branches, which are imbedded in the surrounding rock. Where the column is curved, these stolons are chiefly from the inner side of the curve, and very rarely upon the outer side. Whether we regard the columns in these parts as having grown in an erect or recumbent position, the circumstance that these appendages grow only from one side is equally interesting and remarkable; and this is not confined to the large columns, but occurs in the smallest individuals observed. The great uniformity in the columns, though of extremely different size, together with the characteristic appendages, renders the species readily recognizable; for which reasons I have designated it, although not knowing the structure of the body.

PLATE III A.

Fig. 2. A fragment of the column of this species.

PLATE III B.

Fig. 3, 4, 5, 6 & 7. Several fragments of columns of different sizes, each showing the small attached rootlets, or the points from which they have been broken off.

Geological position and locality. In the lower part of the shaly limestone of the Lower Helderberg group : Helderberg mountains and Schoharie.

Platycrinus plumosus (n. s.).

PLATE IV. FIG. 1 – 5.

BODY small, cupform, expanding and subpentagonal at the bases of the arms : surface finely granulated. Basal plates three, wider than long, very thin; point of attachment for column very small. Costal or first radial plates six, large, thin, wider than long, deeply excavated upon the upper margin for the insertion of the second radial plate and the base of the arms : surface prominently convex in the middle, below the second radial. Second radial plates small, short, subquadrangular, filling the excavation in the upper edge of the larger first radial, and not extending as high as the upper margin. Anal plates two [visible]; the first large heptagonal, the second much smaller and hexagonal. First brachial plate pentagonal; vertical sides short; base straight; two upper sloping sides supporting the bifurcating arms.

ARMS simple from this point to their extremities, more than five times as long as the body : joints numerous, wider than long, each one giving origin to one or two tentacles from each side. Tentacula long, slender; joints angular, nearly twice as long as wide : surface granulated like the body and arms.

PROBOSCIS about two and a half times as long as the body, composed of hexagonal or irregular plates, which become smaller towards the summit.

COLUMN round, very slender; consisting, near the body, of alternating larger and smaller joints, each large joint giving off a series of five long slender branchlets, which closely embrace the body and base of the arms, reaching nearly to the extremities of the arms themselves.

The closely arranged branchlets, near the summit of the column, cover and obscure the structure of the base of the specimens figured. The arms are not preserved entire; but from the gradually tapering form and small joints, we may infer that they continue simple above the first bifurcation. In the specimen (fig. 3) which preserves a part of the proboscis, the anal plates are conspicuous, while their connexion with the proboscis is destroyed, and only the upper portions are preserved. The whole specimen has been much crushed, and the arms and tentacula are involved with the crushed proboscis.

Fig. 1. A specimen preserving a part of the column, with the branchlets broken off. The body is too imperfect to be represented in detail, but the arms and tentacula correspond to those of fig. 2.

Fig. 2. An individual nearly entire, with a small portion of the column and branchlets attached, and nearly covering the body. The arms are preserved nearly to their extremities.

Fig. 3. An individual much crushed, showing the structure of the body and a portion of the proboscis. The small point for the attachment of the column is well shown in the figure.

Fig. 4. Enlargement from fig. 2 of the first and second radial plates, the first arm joint, and succeeding plates of the arms and tentacula.

Fig. 5. Structure of the body and base of arm, from fig. 3.

Geological position and locality. In the shaly partings of the Pentamerus limestone of the Lower Helderberg group: Jerusalem hill, Litchfield, Herkimer county.

Platycrinus parvus (n. s.).

PLATE IV. FIG. 6 – 9.

BODY very small. Basal and first radial plates obscure. Second radial plates filling the excavation in the upper margin of the first radial.

ARMS bifurcating upon the first brachial plate, and continuing simple to their extremities: joints of the arms about as wide as long, giving origin to one or two tentacula on each side. Tentacula composed of rounded joints, which are about as long as wide.

COLUMN round, slender; consisting, near the body, of alternating large and small joints, and below, of a greater number of small joints alternating with the larger ones. The large joints give origin to long slender branchlets which are closely clustered around the body, and

extend beyond the extremities of the arms and tentacula. Surface of branches very finely granulate, where preserved : the surface is for the most part much worn.

This species differs from *P. plumosus* in the small size and shorter arms, which are, however, not entire at the extremities. The joints of the arms are of about the same length, but the joints of the tentacula are shorter and less angular. The larger joints giving off the branchlets are closely arranged near the body, and become gradually more separated as the column extends; so that four, five, or more thin joints are intercalated between the thicker ones. The little branchlets sometimes quite envelope the body and arms, some of them extending beyond the latter as represented in the plate.

Fig. 6. An individual nearly entire, with a small portion of the column from which originate the numerous branchlets which surround the body and extend beyond the arms.

Fig. 7. A similar specimen, preserving more of the column, from which most of the branchlets have been removed.

Fig. 8. Enlargement of a portion of the column (lower part of fig. 7), with the bases of the branchlets attached.

Fig. 9. Enlargement of a single branchlet.

Geological position and locality. In the shaly interlaminations of the Pentamerus limestone of the Lower Helderberg group : Jerusalem hill, Litchfield, Herkimer county.

Platycrinus ramulosus (n. s.).

PLATE IV. FIG. 10 – 13.

BODY small. Basal plates much wider than long. Radial plates comparatively large, wider than long, very prominent just below the insertion of the second radial plate, and contracted towards the upper lateral angles. Second radial plate very small.

ARMS bifurcating upon the first brachial plate, and again upon the tenth plate above this : joints of the arms wider than long, rounded exteriorly, giving origin on their inner margin to strong rounded tentacula ; joints of the tentacula apparently a little longer than wide.

COLUMN round, somewhat large ; consisting, near the body, of very thin plates, which become thicker at a greater distance.

This species differs conspicuously from either of the others, in the second bifurcation of the arms, and in the proportionally larger column, made up of thin plates near its junction with the basal plates. The basal plates are inconspicuous and somewhat injured in the specimen described; but the first radial plates are well defined and very prominent in the middle, while the excavation in the upper margin is less deep than in *P. plumosus*, while the arms and tentacles differ in an equal degree from that species. In the specimen, fig. 11, there is some irregularity in the bifurcation of the arms, and it is possible that this one may prove a distinct species.

I am not able to state whether the column of this species, like the others, is furnished with appendages or branchlets.

Fig. 10. A small individual, preserving the arms above the second bifurcation.

Fig. 11. An individual showing some irregularity in the bifurcation. The same specimen shows also two anal plates.

Fig. 12. Several joints of the arm, with tentacles attached.

Fig. 13. Enlargement showing the structure from the first radial plate to the extremities of the arms, as far as preserved in the specimen fig. 10.

Geological position and locality. In the shaly layers associated with the Pentamerus limestone of the Lower Helderberg group : Jerusalem hill, Litchfield, Herkimer county.

Platycrinus tentaculatus (n. s.).

PLATE V. FIG. 1 – 4.

BODY broad cupform, scarcely subpentagonal above : surface of plates ornamented by radiating ridges or striæ. Basal plates short, much wider than long, marked by an elevated circular ridge just without the circumference of the column, and thence to the upper margin by radiating ridges, which meet corresponding ones from the radial plates at their junction. First radial or costal plates symmetrical, nearly twice as wide as long; upper margins slightly concave, thickened in the middle above, and from this point radiate strong ridges to the base and lateral margins, but not to the upper margin. Second radial or scapular plates broadly triangular; the base slightly convex, and the upper margins very gradually sloping from the lateral angles. Brachial plates two, pentagonal; resting one on each of the upper sloping sides of the second radial plates, joining at their contiguous margins, and resting their outer edges upon the interbrachial plates.

ARMS bifurcating upon each of the first brachial plates; the first four or five articulations of each being simple plates of an unequal quadrangular form, and gradually passing into a double series of interlocking wedgeform or somewhat hexagonal plates, which have their outer and upper angles thickened and obliquely truncated for the attachment of the strong tentacles. Tentacula composed of long joints, which are thickened at their bases and articulating extremities. Interbrachial plates heptagonal; the two lower sides resting on the adjoining radial plates, and laterally upon each side against the first and second brachial plates.

PROBOSCIS unknown.

COLUMN round; in the small portion attached to the specimen, consisting of alternating thicker and thinner articulations.

This beautiful and well-marked *Platycrinus* presents all the characteristic features of the genus as seen in the Carboniferous species. In all its external characters, it differs from either of the species just described: the basal plates are proportionally smaller; and these, with the first radials, are strongly marked by radiating ridges or striæ. The upper edge of the first radial is not deeply excavated, as in those, but is broadly and slightly concave; and the second radial is a low triangular plate with a long base. The second radial supports two instead of one brachial plate; and upon each of these the arm-plates bifurcate, giving origin to four arms from each ray, or twenty altogether. The joints of the arms are very prominent externally, and the thickening of the upper truncated angle gives them a peculiar appearance. The tentacula are remarkable in the thickened articulating extremities; in which respect they differ not only from the preceding species, but from all the carboniferous forms that have fallen under my observation. The arms of the specimen are not entire, the portion remaining being more than four times as long as the body.

Another specimen of what appears to be the same species, enclosed in the solid stone and broken through the middle, shows a long slender proboscis.

Fig. 1. The individual represented of the natural size.

Fig. 2. Enlargement of arms and tentacles from the second radial plate; the two contiguous arms of the two pairs being continued with the tentacles as far as seen in the specimen.

Fig. 3. Enlargement of the plates from the basal through the radial and brachial plates, and continuation of a single arm.

Fig. 4. Diagram showing the structure.

Geological position and locality. In the calcareous layers of the shaly limestone of the Lower Helderberg group, Schoharie.

Genus Brachiocrinus (n. g.).

[Gr. βραχιον, *brachium*; κρινος, *lilium*.]

Body unknown or none.

Arms composed of numerous articulations arranged in single consecutive series (or of pentagonal joints in double series?). Base of arm rounded, without articulating surface. Tentacula composed of thickened node-like joints.

Brachiocrinus nodosarius (n. s.).

Plate V. Fig. 5 – 7; and Plate VI. Fig. 1 – 3.

Body unknown.

Arms very long, composed of numerous articulations arranged in single series, very convex exteriorly and flattened or slightly concave on the inner side, very gradually diminishing from the base. Articulations nearly three times as wide as long: from every fourth or fifth, and sometimes from each third joint, originates a tentacle on one side, and one from the next succeeding joint on the opposite, giving them the appearance of being opposite and in pairs. Tentacula composed of thick bead-like joints, which increase in size from the base to the middle, and thence diminish to the extremities. Section of tentacula round, with a linear foramen, and without any appearance of a groove or canal on the inner side.

Although I have seen no part of a body which could be regarded as belonging to this crinoid, the character of the arms is so peculiar, that I am induced to designate the genus from the feature presented in these appendages. The arms are sometimes much elongated, as seen in the specimen, Plate v, fig. 2, which is nearly four inches in length and still far from being entire. There is often much irregularity in the distance from each other of the tentacula: in several specimens, they originate at every fifth or sixth plate of the arm; while in one individual, the greater number originate on every third or fourth plate; and in one or two instances, there is only a single intervening plate. I have also noticed that upon the inner side of the arm, the two adjoining plates bearing tentacles on the opposite edges are sometimes anchylosed, presenting the appearance of a single thick plate.

The arm terminates below in a rounded condyle, without any appearance of an articulating surface or point of attachment to any other body; as if the arm, as it now occurs, had had an independent existence; or at least had the power of secreting calcareous matter to cover the broken and rough extremity, if broken from a body of the usual character of crinoids. This condyle-like extremity of the arms is figured on Plate v, and in a separate fragment represented on Plate vi, fig. 2 & 3.

PLATE V.

Fig. 5. A specimen with the tentacles more closely arranged than usual, and terminating below in a round condyle-like extremity.

Fig. 6. A specimen preserving eight of the tentacles upon one side of the arm, and four upon the other.

Fig. 7. An arm coiled, showing the points of attachment, with numerous detached fragments of tentacula.

PLATE VI.

Fig. 1. The inner side of an arm with tentacles attached, showing on the right side one at unequal distance from the others.

Fig. 2 & 2 a. Inner side of the base of an arm including the first three joints, with points of attachment for the tentacles *t*, *t*; and the same enlarged.

Fig. 3. Exterior surface of the same enlarged.

Fig. 3 a. Transverse section, showing the form of the arm-joints.

Geological position and locality. In the lower part of the shaly limestone of the Lower Helderberg group: Helderberg mountains and Schoharie.

Genus Edriocrinus (n. g.).

[Gr. εδριαω, *sedeo*; κρινος, *lilium*.]

Body subconical. Base solid, without division into plates: upper margin marked by six angles, with depressions between for insertion of radial plates. Radial plates five, inserted in the five larger depressions on the upper edge of the calyx. Anal plates two, the lower one inserted in the smaller of the six impressions on the upper margin of the calyx; the second anal plate placed on the upper edge of the first. Brachial plates numerous, consisting of thin plates in consecutive series resting upon the upper concave edges of the radial plates: pinnules subdivided above. Tentacula unknown.

Proboscis unknown.

Column none.

This genus is constituted to receive some very peculiar crinoidal remains, which, till within a short period, were not fully understood. In the arrangement and engraving of Plate v in 1855, the figures 8 to 12 inclusive express all that was then known regarding these fossils; which had been observed as hemispheric or subconical bodies with entirely smooth surfaces, giving no evidence of the point of attachment for a column, and having the margins adhering to the imbedding stone, or the cavity filled. On carefully freeing several of these from the stone, the forms and character presented in the figures became apparent. In fig. 12, the cavity appears as if closed above by a solid concave plate; but this probably results from a thickening of the walls, or from the thickening of the exterior wall alone, the concave plate representing the base of the interior original cavity. The depressions were evidently intended for the reception of other plates, which at that time were entirely unknown.

Recently I have obtained from Mr. ANDREWS of Cumberland, Maryland, a series of specimens which fully illustrate the characters of the genus so far as regards the plates of the body and arms, and also prove the mode of growth. By reference to Plate LXXXVII (Crinoideæ of the Oriskany sandstone), it will be seen from several examples that these crinoids are sessile in the young state, adhering singly or in groups to other substances until fully developed, when they are separated from the foreign bodies, and, gradually secreting calcareous matter to cover the cicatrix or point of adhesion, become finally the smoothly rounded bases which we find so numerously in the shaly limestone of the Lower Helderberg and the Oriskany sandstone.

In this progress of growth and separation, the base of the crinoid undergoes many modifications of form; presenting itself with the angular outlines of the recently attached surface, or with these angles removed, and the cicatrix in various stages of obliteration, until finally the base becomes smooth and rounded, but varying greatly in proportions of length and breadth.

In the Oriskany sandstone, these bodies are equally as abundant as in the shaly limestone of the Lower Helderberg; and they not unfrequently preserve the radial plates at the base of the arms.

Edriocrinus pocilliformis (n. s.).

PLATE V. FIG. 8 – 12.

BASE hemispheric or subturbinate, often less than a hemisphere, externally smooth or finely granulate: upper margin scollopped with five large and one smaller depression for the insertion of the radial and anal plates. Interior more or less deeply concave, with depressions corresponding to those on the edge of the cup; the concavity not parallel to the exterior convexity. Radial plates and arms unknown.

This small species occurs in considerable numbers in the central part of the shaly limestone, varying in size from that of half a pea to more than half an inch, and of greater proportional differences in elevation. A few retain some evidence of their former attachment to other bodies, but for the most part they are quite smooth upon the exterior. This part of the crinoid appears to be composed of an exterior and an inner plate; the inner not corresponding with the outer one in its concavity, the exterior form being given by the process of separation from its sedentary position, and the subsequent secretion of calcareous matter to form a smooth surface. In some instances the interior presents scarcely any appreciable concavity, and the entire basal portion is then much wider than high.

These bodies are usually so small as to be overlooked, or regarded as unimportant fragments of crinoids; and are rarely seen in collections.

Fig. 8. Basal view of a large individual, the proportional length being greater than usual.

Fig. 9. Lateral view of the same.

Fig. 10. Lateral view of a larger specimen.

Fig. 11. Interior of the same.

Fig. 12. Enlargement of the concavity of fig. 10, showing the depressions corresponding to the depressions in the margin and the concentrically striated surface. At each angle there is a slight depression or pore, which seems to communicate with the cavity between the basal and inner plate.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains, Albany county.

Genus Aspidocrinus (n. g.).

[Gr. ἀσπις, *scutum*; κρινος, *lilium*.]

Base broadly circular, depressed hemispheric or scutelliform: upper margins plain or plicate exteriorly; the articulating edges irregular. Radial plates and arms unknown. Point of attachment for column distinct, small.

The specimens referred to this genus present themselves as broad scutelliform bases of crinoids, or sometimes nearly hemispheric in form. The margins, sometimes plain, at others irregular, present but doubtful surfaces of attachment for succeeding plates. In one or two individuals, I have observed depressions in the upper margins similar to those of *Edriocrinus pocilliformis*, which would indicate at least ten or twelve radial and interradial plates; but no specimen has yet been seen, retaining any of the second range of plates. There are many analogies between this form and the bases of *Edriocrinus*; but the conspicuous mark of attachment for the column, and the indication of numerous plates in the second series, preclude the union of the two in a single genus.

Aspidocrinus scutelliformis (n. s.).

Plate V. Fig. 15 – 18.

Base scutelliform, concavo-convex, depressed hemispheric: exterior smooth or finely granulate; interior smooth. Radial plates and arms unknown.

Column unknown. Point of attachment small, circular.

These bases of this species of *Aspidocrinus* are extremely abundant in the upper part of the shaly limestone of the Lower Helderberg group, and sometimes form by themselves mainly, and with other fragments of crinoids, a stratum which, from the abundance of these forms, was originally designated, in the Annual Geological Reports of New-York, as the "*Scutella* limestone." This rock is so filled with these remains, that many thousands may be counted in the space of a few yards; and the other portions of the rock are made up in great measure of these broken cups and other crinoidal remains. In some parts of the rock they become rare, and in its western and northwestern extension are at present unknown. Although fragments of undetermined columns are abundant in the formation, I have not thus far been able to identify any of them as belonging to this species.

Fig. 15. The exterior of the base of an individual of this species.

Fig. 16. The interior of the same.

Fig. 17. Profile or lateral view of the same.

Fig. 18. The interior of a large specimen.

Geological position and locality. In the upper part of the shaly limestone of the Lower Helderberg group, and in the "Scutella limestone": Helderberg mountains, and Schoharie.

Aspidocrinus callosus (n. s.).

PLATE V. FIG. 13 & 14.

BASE small, rounded below, somewhat quadrangular and much thickened above; having prominent rounded points or nodes, with narrow spaces between.

This form bears as much analogy to the root as to the calyx of a crinoid, and may perhaps be only this part of the individual. Other similar forms exhibit a variable number of thickened marginal nodes; although there is no appearance of small rootlets, as is usual, and the point of attachment for the column is quite small.

Fig. 13 & 18. Interior and exterior views of the specimen described.

Geological position and locality. In the shaly limestone of the Lower Helderberg group: Helderberg mountains, and Schoharie.

Aspidocrinus digitatus (n. s.).

PLATE V. FIG. 19 & 20.

The specimen figured has, in some respects, so much the character of a root, that it is not easy to suppose it to have been anything else; but the mode of attachment of the column is precisely as in the calyx of a crinoid, and entirely unlike ordinary roots of these fossils. The divisions terminate abruptly, without any evidence of prolonged rootlets, or of any mode of attachment whatever upon the lower side.

Fig. 19 & 20. Upper side and profile view of the specimen.

Geological position and locality. In the shaly limestone of the Lower Helderberg group, Schoharie.

GENUS CORONOCRINUS (n. g.).

[Gr. κορωνη, *corona*; κρινος, *lilium*.]

BODY very broad, hemispherical? towards the upper margins composed of numerous plates.

ARMS numerous, proceeding from the upper margin of the body: summit flat, composed of numerous small plates.

COLUMN and base unknown.

Coronocrinus polydactylus (n. s.).

PLATE VI. FIG. 4 – 6.

BASE unknown : upper part of body, near the base of arms, composed of numerous small plates. Summit nearly flat, composed of numerous minute hexagonal plates.

ARMS numerous (about forty), consisting of a double series of plates, which are wedgeform and closely interlocking at their inner edges, and rising abruptly from the same line at the upper margin of the body.

PROBOSCIS unknown.

The specimen from which the genus and species are described is a portion of the circumference of the body, which has originally been nearly three inches in diameter on the crown. The arms proceed abruptly from the upper margin of the body. The summit is slightly depressed just within the arms, and thence towards the centre is slightly convex. The fragment preserves the bases of eleven arms; and as it is scarcely more than a fourth of the circumference, we may infer that there were forty arms on the entire individual. The construction of the body as far as seen, with the mode of origin of the arms, the character of the summit, etc., are sufficient to indicate the form as a distinct generic type.

Fig. 4. Lateral view of a fragment of the upper part of the body and bases of the arms.

Fig. 5. View of the summit, showing its structure, and the origin of the arms.

Fig. 6. Enlargement of some plates of the summit.

Geological position and locality. In the shaly limestone of the Lower Helderberg group, Schoharie.

COLUMNS OF UNDETERMINED CRINOIDEÆ.

PLATE III A.

Fig. 3 & 5. Fragments of columns of different species of crinoids, probably of *Mariacrinus*.

Fig. 13. A root and base of the column of a species of *Mariacrinus?* probably *M. pachydactylus*.

Fig. 14. Fragment of a column with long node-like joints; its relations unknown.

PLATE VI.

Fig. 7, 8, 9 & 10. Fragments of pentagonal columns, bearing nodes at the angles, which seem to have been the bases of little branchlets.

Fig. 11, 12 & 13. Sections of pentagonal columns, showing varying degrees of angularity, till in the last one the angles project in wing-like appendages.

Fig. 14. Fragment of Lower Pentamerus limestone, with pieces of columns of two or more species.

Fig. 15. Section of a pentagonal column, showing marks of longitudinal division at the angles.

CYSTIDEÆ OF THE LOWER HELDERBERG GROUP.

GENUS LEPOCRINUS*, OR LEPADOCRINUS (CONRAD).

In his Annual Report for 1840, Mr. CONRAD introduced the following notice of a new crinoid:

"*Lepocrinites gebhardii.* By this name I introduce a singular fossil found "by Mr. GEBHARD. The body is composed of plates of unequal sizes, a "few of which have ambulacra, connecting this fossil with the Echino- "dermata: lower half of the column apparently solid, and traversed "by a pentagonal canal."

Figures of the bases of the column of this fossil were given in the Final Report of Mr. VANUXEM on the Third Geological District of New-York, 1842; and the same, with a figure of the entire fossil, was given by Mr. MATHER in his Report on the Geology of the First District, 1843, page 346, under the name previously proposed by Mr. CONRAD.

* The name *Lepocrinites* was given from the resemblance to the Lepas or Barnacle, *Anatifa*, and is properly *Lepadocrinus*. It will be noticed that these observations upon the relations of this fossil were published five years before the paper of VON BUCH on Cystideæ.

In 1848 the late EDWARD FORBES published, in the Memoirs of the Geological Survey of Great Britain, Vol. ii, Part ii, an article "*On the Cystideæ of the Silurian Rocks of the British Islands*," in which he redescribed the Genus *Pseudocrinites* of PEARCE, and proposed for another one of similar structure the name *Apiocystites*. The essential structure of the body does not differ in these two genera; and it was mainly upon the mode of lodgment of the arms in the grooves upon the surface of the body, and the peculiar mode of articulation of the ossicula, that the distinction was founded.

I have identified a species of the Genus *Apiocystites* in the Niagara group, which is published in Vol. ii, Palæontology of New-York; remarking at the same time upon the close agreement in character between *Lepadocrinus* of CONRAD, and *Pseudocrinites* as described and illustrated by Mr. FORBES.

In the Genera *Lepadocrinus*, *Apiocystites* and *Callocystites*, the structure and arrangement of the arms and fingers are so similar, that upon the characters presented by these alone, no generic distinction could be made. It does not appear to me to be fully shown that these appendages in *Pseudocrinus* are so different from those of *Apiocystites*, as to warrant the establishment of a distinct genus; and regarding fundamental structure as the more important character, I would feel disposed, from the knowledge at present possessed, to include *Lepadocrinus*, *Pseudocrinus* and *Apiocystites* under one generic term.

Although the description of Mr. CONRAD, published in 1840, was too incomplete to enable one to recognize the fossil, yet the figure given in Mr. MATHER'S Report in 1843 was quite sufficient to attract attention; and I can only suppose that this volume had escaped the notice of Mr. FORBES, or he would have made some comparisons of this genus and species with the British cystidians described by him in 1845.

Following Mr. FORBES in my second volume of the Palæontology of New-York, I adopted the name *Apiocystites* for a species in the Niagara group; supposing at the same time, with the specimens which were then before me, that I should find sufficient distinctions between that fossil and the one under consideration, to sustain the Genus *Lepadocrinus* also. After careful comparison of all the specimens in my possession, I am unable to observe any generic distinctions between the Niagara and the Lower Helderberg forms. I shall, however, continue the use of the name *Lepadocrinus*, since it has precedence in point of time, and is now pretty well known among geologists of the United Strtes.

The structural differences between the *Lepadocrinus* of the Lower Helderberg and the *Apiocystites* of the Niagara are not greater than occur in many species of crinoids of the same genus, where various modifications take place in the plates of the upper part of the body; and even in two specimens of the same species of *Apiocystites* in the Niagara group, there are differences quite as great in the arrangement of the upper plates, as between that species and the one now under consideration.

Lepadocrinus gebhardi (Conrad).

Plate VII. Fig. 1 – 20.

SYNONYMES AND REFERENCES.

Lepocrinites gebhardi : Conrad, Annual Report on Palæontology of New-York, 1840, p. 207.
— — Vanuxem, Geol. Report of Third District of New-York, 1842, p. 117, f. 4.
— — Mather, Geol. Report of First District of New-York, pp. 346 & 247, f. 4, 5.

Body oblong, oval or ovoid, compressed at the sides, unsymmetrical, being much more gibbous on the lower part of the posteal or ovarian side than on the opposite; usually abruptly rounded above and obliquely subtruncate below. The basal series consists of four unequal plates, 1, 2, 3, 4; the second series of five, 5, 6, 7, 8, 9; the third series of four, 10, 11, 12, 13; and the fourth or supraovarion of five, 14, 15, 16, 17, 18 : making the formula B, $4 + 5 + 4 + 5$. The supraovarian plate extends downwards on each side, half enclosing the aperture : ovarian and circa-ovarian plates unknown. Plates of the summit unknown. A reniform depression and anal pore a little upon the left of the centre.

Arms four, consisting of an anterior and posterior pair, which lie in shallow grooves along the rounded angles of the body, reaching nearly or quite to the base, and rising much above the surface of the adjoining plates; the anterior pair nearer to each other than the posterior pair, extending downward nearly to the base. The arms are composed of a double series of plates, each alternate one being similar. A range of minute ossicula extends along the centre of the groove between the plates of the arms, from which diverges a shorter range to the sinuosities of the arms, where originate the fingers or pinnules. Fingers slightly alternate, but preserving the appearance of being in pairs or opposite; composed of a double series of ossicula, closely interlocking at their contiguous wedgeform margins, and standing erect from the surface of the body, or lying close upon the arms and infolded in pairs beneath each other. Surface of plates granulate; the granulations

without definite arrangement, or in concentric lines parallel to the margins of the plate, and often elongated in the same direction, sometimes even forming continuous ridges. The pectinated spaces on the basal plate, and on 12 and 13, are elongate reniform, and those on the adjoining plates are triangular; neither being symmetrical or equilateral. From twenty to thirty bars may be counted in each of the pectinated spaces.

COLUMN composed of two distinct parts : the upper, consisting of about fifteen articulations, is flexible; and the lower part, larger and of greater length, consists often of nearly twice as many joints, which are anchylosed together, and usually covered on the exterior by a calcareous secretion of greater or less thickness.

This fossil is better known in the rocks from the occurrence of numerous spindle-form bases of the columns, which taper gradually downwards, and contract abruptly at the upper end : these being solid, are preserved entire, while the upper parts of the column, with the body, have been destroyed. These columns are often silicified, sometimes entirely free from any marks of articulations, but, when well preserved, presenting a granulose surface; the granules often arranged along the line of the joints, but sometimes indiscriminately scattered over the surface. When these solid bodies are partially worn, the articulated character is distinctly shown; and they are seen to be composed of plates with deeply striated articulating surfaces, which are thus strongly interlocked. In the upper part of the column the outer margins of the joints overlap the next one below, and the jointed structure may sometimes be traced into the upper part of the solid portion. The lower part of the column is rarely preserved without thickening of the surface, as in fig. 7.

The form of the body is like *Apiocystites* of the Niagara group, but more expanded in the upper part, and with a greater proportional dissimilarity between the anteal and posteal half of the body. It differs much from *Callocystites*, and indeed from all the other cystidians of the Lower Helderberg and Niagara group, none of which are known to possess the character of having the lower half of the column solid. In the arrangement of the arms there is no essential difference between this and *Callocystites* or *Apiocystites*, except that in this one the ossicula are somewhat more prominent above the plates of the body.

The species has a wide distribution, having been found in fragments over many hundred miles in extent, and indeed almost wherever the formation is known; and the great numbers of these fragments indicate the abundance of the species in these ancient seas.

Fig. 1. The right side of an individual, showing the arrangement of plates, pectinated rhombs, etc.

Fig. 2. The anterior side, showing the pectinated rhombs at the base.

Fig. 3. The posterior side, showing the ovarian aperture with the surrounding plates removed.

Fig. 4. The left side of the same specimen. The prominence of the ovarian side over the opposite is well seen in fig. 1 & 4.

Fig. 5. A smaller individual with the column entire and the body mutilated. The base of the column is quite solid, showing no evidence of rings.

Fig. 6. Another individual preserving the column and plates of the body, the latter somewhat crushed. The articulations are partially visible in the base of the column, which condition is in a measure due to wearing of the surface.

Fig. 7. A small specimen showing the pectinated rhombs and structure of the body on the right side. The column is nearly entire, showing the articulations from base to summit with almost equal distinctness. The fingers are converged together above the summit of the body, giving it a pointed appearance.

Fig. 8. The body somewhat broken, but preserving the fingers or pinnules to the length of three-fourths of an inch.

Fig. 10. The summit of a specimen much crushed, but preserving a portion of the arms and fingers.

Fig. 11. A single plate of the second range enlarged, showing the character of surface, the pectinated rhomb, etc.

Fig. 12. Enlargement of a portion of a plate, showing surface markings.

Fig. 13. Enlargement of a part of an arm, with the fingers folded down upon the body of the fossil.

Fig. 14, 15, 16. Bases of several columns, the two first showing slight evidences of rings, while the other appears quite solid.

Fig. 17, 18. Enlargements of the surfaces of the solid bases of columns.

Fig. 19. Transverse section at the top of the solid portion, showing the central canal and the rings within the exterior wall.

Fig. 20, 21, 22. Lateral and sectional views and enlargement of a fragment of a large column, which exhibits characters very similar to the base of *Lepadocrinus*.

Geological position and locality. In the Pentamerus limestone of the Lower Helderberg group : Helderberg mountains, Schoharie, Cherryvalley, Cedarville, Jerusalem hill, and many other places in New-York; and Cumberland, Maryland.

Genus Sphærocystites (n. g.).

[Gr. σφαιρα, *sphæra*; κυστις, *vesica*.]

Body spheroidal, wider than high. Arms in two principal pairs, with numerous bifurcations. Brachial sulci obliquely lobed. Mouth longitudinal? apicial : anus subapicial : ovarian opening upon the summit. Basal plates four; those of the series above not determined. Base depressed.

Column unknown.

This fossil, though having the general aspect of *Callocystites*, or *Lepadocrinus*, I have characterized as a distinct genus, from the remarkably rotund form, the numerous branching arms, the position of the ovarian opening upon the summit, and the narrow elongated pectinated rhombs, the two upper of which are remarkable for being upon the summit and having their direction almost precisely at right angles to each other. The whole fossil is silicified; and from this cause, and the numerous ramifications of the arms, the junction of the plates is obliterated; but the depressed spherical form, and the disposition of the rhombs, indicate an essential modification of the plates compared with *Lepadocrinus*.

Sphærocystites multifasciatus (n. s.).

Plate VII A. Fig. 1 – 4.

Body spheroidal : height or length a little less than the transverse diameter; length from anteal to posteal extremity greater than the transverse diameter. Base excavated for the reception of the column. Basal plates four : plates of second and higher series unknown. Ovarian aperture at the summit, midway between apex and margin. Mouth central and longitudinal? Anal pore subapicial, a little upon the left side. Pectinated rhombs extremely narrow and elongated, scarcely dissimilar in form : as many as forty bars may be counted in a single one of these spaces.

Arms in two pairs, composed of small plates lodged in shallow lobed grooves, which are numerously and irregularly divided below till the entire surface is covered by their ramifications.

Column unknown, but probably similar to that of *Lepadocrinus*.

The proportions of height, transverse and longitudinal diameters, are, in a single well-preserved specimen, almost precisely as 5, 6 and 7; and a smaller specimen scarcely varies from these proportions. The surface is covered with grooves, from the numerous subdivisions of the arms. In some specimens the ossicula are but partially preserved, while in others they are almost entire; but from the silicified condition of the body, it is not easy to distinguish the ossicula of the arms from the granulations of the surface where exaggerated by this silicification. The most important only of the subdivisions are shown in fig. 1, 2 & 3; it being impossible to trace the others satisfactorily. In fig. 4, these ramifications are shown as they exist in that specimen.

Fig. 1. The left side of the specimen, natural size.

Fig. 2. The summit, showing the origin and distribution of the arms, the upper pairs of pectinated rhombs, the ovarian and anal orifices, etc.

Fig. 3. The base of the same specimen, showing the lower pectinated rhomb, the ramifications of the arms, and the cavity for the insertion of the column.

Fig. 4. Diagram illustrating, as far as traced, the distribution of the arms upon the surface of the specimen figured.

Fig. 5. An enlargement of one of the pectinated rhombs.

Geological position and locality. In the limestones of the Lower Helderberg group: Cumberland, Maryland.

Among the remains of Cystidians from the Lower Helderberg group, is a small one, crushed, presenting on opposite sides a very dissimilar character, and without any evidence of brachial grooves upon the surface, or pectinated rhombs. The column is deeply inserted in the base, one side of which is longer than the other. I had designated this fossil as *Anomalocystites*, without being able, from the specimens then in my possession, to understand fully its structure and relations. More recently I have succeeded in determining the form and agreement of certain parts from a specimen of a different species of the same genus, from the Oriskany sandstone of Cumberland, Maryland.

This specimen is somewhat elliptical on its lateral margins, with a deeply concave base, the summit being imperfect. One side of the specimen is convex, composed of numerous and variously shaped plates; while the other is distinctly concave, and has on each side a sharp angular margin formed by the abrupt bending of the plates along the two

edges. On the concave side at the base are two large and strongly arching plates, which extend in long angular points to the lower angles of the concave side; the angles being occupied by a bent carinate plate, of which the lower narrow extremity reaches to the base of the body.

On the convex side the base is longer, and formed of three distinct plates, the central one of which is hexagonal and the others apparently pentagonal. On the concave side, the basal plates are succeeded by a large irregular central plate, and this one by a range of smaller plates; while the angles present each three plates in direct succession. The convex side above the base shows, somewhat irregularly, five ranges of small plates. The summit is broken off.

A specimen from the limestone has two round spine-like processes, one from each side of the summit, which, under a lens, appear not to be jointed; and from the centre is a projection which may be a short proboscis, or the ovarian plates protruded from pressure. These parts, however, are too obscure to be characteristic; and so far as regards generic relations and differences, we must rely upon the fundamental structure of the body, from the irregularity of which I propose to designate this fossil.

GENUS ANOMALOCYSTITES (n. g.).

[Gr. ανωμαλις, *irregularis*; κυστις, *vesica*.]

BODY semielliptical or semiovoid: sides unequal; the vertical outline oval or ovoid, plano-convex or concavo-convex; the transverse outline semielliptical, the base of which is straight or more or less concave: the two sides composed of an unequal number of plates. Basal plates three on the convex side, two on the concave side: second series, two large plates at the angles, and four (or five?) on the convex side; third series, four on the convex side, one at each angle, and a large plate on the concave side; a fourth, fifth, and sixth series of plates on the convex side, and a fourth series on the concave side. Base oblique, with the convex side longer, and a deep concavity for the insertion of the column. Pectinated rhombs apparently none.

ARMS unknown.

COLUMN deeply inserted into the body, composed of large joints above, becoming smaller below.

Anomalocystites cornutus (n. s.).

PLATE VII A. FIG. 5 – 7.

BODY subovoid, longitudinally concavo-convex. Concave side showing two basal plates and a part of two basi-angular plates, one large subcentral plate with two lateral plates, one irregular one on the upper lefthand angle of the large central plate, and a terminal range of small plates. Convex side showing three basal plates; the central one hexagonal, succeeded by five series of small plates.

TENTACULA or spines, two or more.

PROBOSCIS?

COLUMN composed of large circular joints at the junction with the body, and becoming rapidly smaller and pentagonal below.

All the specimens of this species which have been seen are crushed, and more or less distorted and imbedded in stone. The form and structure has been more fully understood by comparison with a free specimen of another species from the Oriskany sandstone of Maryland. A single specimen shows a column of an inch in length. The structure in five different individuals corresponds with that represented upon the plate. In one individual there is a projecting spine or tentacle from each side, apparently joining the angles at the summit of the convex side : there may have been more upon the other parts of the summit. A central node or proboscis? is seen in the same specimen.

The plates appear to be marked by transverse subimbricating lamellæ and fine granulate surfaces. No pores, ambulacra, or other openings are visible.

Fig. 5. The convex side of an individual with a portion of the column attached.

Fig. 6. The concave side, showing the two arching basal plates, the large central plate, and the superior range of plates.

Fig. 7. A plate enlarged, showing the lamellar structure.

Fig. 7 a. Diagram illustrating the structure of the body, and the relative position of the plates on the two sides.

Geological position and locality. In the Pentamerus limestone of the Lower Helderberg group : Jerusalem hill, Litchfield, Herkimer county.

GENUS PROTASTER (FORBES).

Memoirs of the Geological Survey of Great Britain, Decade I.

"BODY circular, covered with squamiform plates : genital openings in "the angles of junction of the arms beneath.

"ARMS simple, formed of alternating ossicula."

A large specimen of a similar fossil, preserved in the collections of the New-York Lyceum, was designated by the late Dr. DEKAY as *Euryale annulatum;* but I am unable to find any description of it at this time.

Protaster forbesi (n. s.).

PLATE VII A. FIG. 8 – 10.

BODY circular, small, composed of squamiform plates.

ARMS five, large, subequidistant, composed of a single series of joints with a groove along the centre of the lower side, bearing jointed tentacles on the outer angles of the lower margins.

The under surface of the disc and arms only is seen in the specimen : the scale-like plates are imbricated, and have granulate surfaces. The mouth is central. The buccal apparatus is composed of ten parts arranged in pairs; one-half of each pair springing from the base of each arm at their contiguous sides, and converging so as to form a falcate-lanceolate toothlike process from the sinuosities of the arms, and projecting deeply into the cavity of the mouth. These buccal processes are evidently articulated to the lateral margins of the first joints of the arms, like the succeeding tentacles, and differ little in appearance from those organs. The arm-plates are subquadrate, with concave bases and convex or pointed anterior margins, with a groove along the lower side, and connected together by a small cylindrical canal. The brachial plates, as seen from the lower side, are deeply indented at their base, and pointed above; so that when the arm was contracted, the plates closely interlocked, from the insertion of the pointed extremities into the hollow bases of the succeeding plate. Only four or five of the brachial ossicula of each arm are imbedded in the body; but from their comparatively large size, they have doubtless extended much beyond the disc. The outer lateral margins are indented near the extremities for the insertion of the tentacles, which are composed of two or more joints thickened at the articulating extremities.

Fig. 8. The fossil, natural size.

Fig. 9. Enlargement of the body and arms, with a restoration of the latter in outline beyond the limits of the body.

Fig. 10. Enlargement of portions of an arm and tentacles, as seen from the lower side.

Geological position and locality. In the shaly layers of the Pentamerus limestone: Jerusalem hill, Litchfield, Herkimer county.

Genus Dictyocrinus.

In a plate intended to accompany his Report of 1841, Mr. Conrad has figured and designated a peculiar fossil body by the name *Dictuocrinites.*

The body is turbinate, with an appearance of a cavity at the base for the insertion of a column. The surface is marked by curving impressed lines leaving intermediate rhombic spaces, which are occupied by subimbricating scales.

The *Receptaculites rhombifer* of Rœmer (Beitræge zur Geologischen Kentniss des Nordwestlichen Harzgebirges, p. 30 : *Sphæronites rhombifer?* pl. iv, f. 21) is evidently a similar body, and likewise one of doubtful position in the system as far as its structure is known.

Dictyocrinus squamifer (n. s.).

Plate VII A. Fig. 11 – 13.

Body turbinate. Base slightly truncated, and deeply impressed in the centre as if for the insertion of a pedicle. Surface entirely covered by rhombiform subimbricating scales; those near the base being longer than wide, while the upper ones are wider than long.

The substance of the body is crystalline calcareous spar, solid at the base, but having a depression above as shown at the broken margins.

The relations of this body with the Crinoideæ or Cystideæ are at least doubtful, but the specimen is not sufficient to make any satisfactory determination. The character of the scales, if there were no other solid parts, would indicate a flexible or elastic pouch; and it is scarcely probable that the pedicle was solid, like the columns of crinoids.

Fig. 11. The body, natural size.

Fig. 12. The base, showing cavity for the insertion of a pedicle.

Fig. 13. Enlargement of surface, showing form and arrangement of scales.

Geological position and locality. In the shaly limestone of the Lower Helderberg group, Schoharie.

Tentaculites elongatus (n. s.).

PLATE VI. FIG. 16 – 21.

BODY extremely elongated and very gradually tapering to the apex, which is sometimes slightly curved; marked by strong, sharp annulations, of which more than three occur in the space of the diameter of the tube. Section cylindrical. Surface ornamented by fine close annulating striæ. Length from one to three inches. Annulations four or five in the space of a quarter of an inch at the base of the larger specimens, and about nine in the same space near the apex.

This species presents little variation in character, though there are sometimes thickened annulations, and the edges of others are often obtuse either originally or from weathering. The striæ are often very slightly undulating, and in many specimens these marks are obscure towards the apex. Where the shell is exfoliated, the surface is smooth, and presents the appearance of a series of reversed truncated cones, or short cups, placed one within the other, having all the characters of *Cornulites*.

Fig. 16. An individual of medium size.

Fig. 17. An individual of about the same length as the preceding, slightly compressed below, giving it an apparently greater breadth at the base.

Fig. 18. A large individual having a length of three inches.

Fig. 19. Enlargement of a portion, showing the striæ.

Fig. 20. An individual from which the exterior shell has been exfoliated, showing smooth annulations whose greatest diameter is near the upper edge.

Fig. 21. A portion of the same enlarged, showing the appearance of the annulations magnified.

On one side of the base of the larger specimen, fig. 18, the greater distance between the annulations shows the interior structure with more elongate internodes.

Geological position and locality. In the shaly limestone, and in the Upper Pentamerus limestone of the Lower Helderberg group : Helderberg mountains and Schoharie.

Tentaculites irregularis (n. s.).

PLATE VI. FIG. 22 & 23.

Tentaculites ornatus : VANUXEM, Final Rep. on the Geology of the Third District, 1842, p. 112, f. 3.
— — MATHER, Final Rep. on the Geology of the First District, p. 349, f. 3.
Not *T. ornatus*, SOWERBY in Sil. System, pa. 628, pl. 12, f. 25; and Siluria, pl. 16, f. 11.

BODY small, acicular, tapering to an acute point. Annulations rounded, unequally distant, from six to twelve in the space of one-eighth of an inch : intermediate spaces marked with rounded annulating striæ. Length rarely more than half an inch.

The tube is long and slender, and the annulations frequently do not extend to the apex, often leaving that portion smooth for an eighth of an inch or more. This character, however, as well as the unequal distribution and unequal strength of the larger annulations, is subject to much variation; and this irregularity is one of the most distinctive characters.

The species is extremely abundant on the thin layers of the Tentaculite limestone, surfaces of many inches square being often filled as completely as the fragment represented in fig. 22. The layers thus covered are known in numerous places over an extent of country from thirty to fifty miles, showing the myriads of these creatures that flourished upon the bottom of the ancient sea.

Fig. 22. A small portion of the surface of the stone, showing the abundant distribution of these bodies.

On this same specimen, which has a length of five inches and an average breadth of a little more than one inch, more than five hundred individuals may be counted ; and the layer beneath, for the thickness of a quarter of an inch, is composed almost entirely of these fossils, giving more than ten times as many as can be seen upon the surface.

Fig. 23. Enlargement of a single individual.

Geological position and locality. In the Tentaculite limestone at the base of the Lower Helderberg group : Helderberg mountains, in numerous localities in Albany county; Schoharie, Carlisle, Cherryvalley; near Fort-Plain, Catskill, near Saugerties, Hudson, etc.

CRINOIDEÆ OF THE ORISKANY SANDSTONE*.

Homocrinus proboscidalis (n. s.).

PLATE LXXXIV. FIG. 24 & 25.

BODY subturbinate : base large. Basal plates wider than long, hexagonal. Radial plates about as long as wide : brachial plates resting upon the truncated upper edges of the radial plates.

ARMS bifurcating upon the third brachial plate, and again upon the third and fifth or sixth plate above the first bifurcation : bifurcations apparently equal.

PROBOSCIS long, fusiform, very slender below, and acquiring its greatest diameter at about two-thirds the distance from base of body to summit of proboscis.

COLUMN unknown.

This little species resembles the *H. scoparius* of the Lower Helderberg group, but differs somewhat in the arrangement of the plates of the body and in the bifurcation of the arms. The arm-plates are not as broad as in that species, and they are more incurved at the margins. It differs more conspicuously in the form of the proboscis, which is composed of plates as in the other species; but being entirely silicified, the structure cannot well be made out.

Fig. 24. The specimen, natural size.

Fig. 25. Enlargement of the body and bases of the arms.

Geological position and locality. In the Oriskany sandstone : Cumberland, Md.

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* I am indebted to Mr. WILPIAM ANDREWS of Cumberland, Maryland, for the valuable and interesting collection of specimens of crinoids of the Oriskany sandstone, as well as for other fossils of the same rock and of the Lower Helderberg limestones.

MARIACRINUS : Subgenus Technocrinus.

In some species of *Mariacrinus* I have noticed a modification of the arm-structure, which is manifested only above the third series of brachial plates, and which affects the parts above that point; giving great difference in the structure of the arms of these species, as compared with the three first described, *M. nobilissimus*, *M. pachydactylus*, and *M. paucidactylus*. In the species of the Oriskany sandstone we have the essential structure of *Mariacrinus*, as far as the commencement of the brachial plates. Above this point, instead of a series of three brachial plates resting on the third radial (as in Plate III, fig. 4 & 10), below the first bifurcation, we have in these forms the bifurcation occurring directly above the first arm-plates, which thus give origin to two pairs or four arms from each ray. The interbrachial plates are also wanting in these species. The arms are simple, or composed of alternating ranges of plates.

The subgenus may be characterized as follows :

TECHNOCRINUS.

BASAL or pelvic plates four. Radial or costal plates three in series of five (3×5). Interradial or intercostal plates four or five. First brachial or scapular plates two resting on the upper sloping edges of each third radial ($2 \times 5 = 10$), which are directly succeeded each by two other plates, or second brachial plates, twenty in number. A second series of similar plates, succeeded by the smaller plates of the arm, which may consist of a single or double series.

Although preferring to characterize the genera of Crinoids from the fundamental structure of the body, leaving those parts above the brachial plates to determine specific distinctions, there seems in this instance some reason for making a subgenus of those forms which present such degrees of variation from the original type as do these species of the Oriskany sandstone. The first deviation is noticed in the *M. plumosus*, which, though having essentially the same structure at the base of the arms, has never-

theless simple arms, or arms of a double series of plates, without armlets; while in the following species a further modification takes place, affecting the structure of the bases of the arms, these appendages themselves preserving the structure of those in *M. plumosus*. Further discoveries may show some intermediate forms, by which these two extremes of development may be united.

The differences here indicated are not dissimilar in value to those on which it is proposed to separate *Ctenocrinus* from *Actinocrinus*. The great number of species under the latter genus renders such differences of more interest than in a genus composed of few species, like the *Mariacrinus*.

Mariacrinus (Subgenus) **Technocrinus spinulosus** (n. s.).

PLATE LXXXV. FIG. 1 – 18.

BODY somewhat spheroidal, slightly contracted at the junction of the arms. Basal plates four, small, wider than long; three pentagonal and one hexagonal, marked by strong radiating ridges. First radial plates about as long as wide; three heptagonal, the others unknown. Second radial plates hexagonal. Third radial plates pentagonal. Interradial plates (on the side fully seen) four; lower one regularly hexagonal. Brachial plates double; one resting on each sloping side of the third radial, and giving origin to a pair of arms. Surface of plates ornamented by ridges and nodes, or short spines.

ARMS composed at base of a single series of joints, becoming double above? Tentacula unknown.

COLUMN somewhat pentagonal, consisting of joints which are deeply striate on their articulating surfaces; each alternate joint furnished with nodes or short spines from the angles.

This beautiful species is readily recognized from its general structure, and from its strongly ornamented surface. The column is obtusely five-angled; and from the deeply striate articulating surfaces, and nodose or spiniferous angles, may be recognized even in small fragments. The alternating joints are without nodes.

The plates of the body, for three or more series above the base, are marked by a central spine or node, which is surrounded by a series of smaller nodes, often, or

usually, corresponding in number to the number of sides of the plate. Outside of the nodes, the plates are marked by strong ridges, which diverge towards the sides of the plates, and converge so as to meet on the lines from the angles to the centre of the plate. The plates of the higher ranges gradually become free from nodes, and are marked only by a central spine which often becomes very conspicuous, so that the higher ranges of plates present a series of spiny crests.

The lower parts of the arms preserved in the specimen appear to be composed of a single series of plates; but it is probable, that, like many others, the succeeding portions were composed of a double series of alternating and interlocking plates.

Fig. 1. The body, and bases of the arms, with a portion of the column attached.

Fig. 2. Structure of the body to the base of the arms, as far as determined.

Fig. 3 – 14. Figures of separated plates from different parts of the body, showing the form, ridges, spines, etc.

Fig. 15 – 18. Joints of the column, showing absence of nodes in some, and varying degrees of development in others.

Geological position and locality. In the Oriskany sandstone : Cumberland, Md.

Mariacrinus (Subgenus) **Technocrinus andrewsi** (n. s.).

PLATE LXXXVI. FIG. 1 – 4.

BODY hemispheric : base large. Surface ornamented by strongly elevated ridges, which radiate towards the margins, and converge along lines drawn from the angles to the centres of the plates. Basal plates much wider than long. First radial plates large, about as long as wide, hexagonal, with one heptagonal. Second radials smaller, and of similar form to those below. Third radials pentagonal, supporting on their upper sloping edges two arm-plates. Interradial plates, one hexagonal, resting on the first radials and lying between the second radials, succeeded by two hexagonal plates (or one hexagonal and one heptagonal), and these again by one large and one smaller plate. Brachial plates two at base, six-sided, resting on the two upper sloping edges of the third radials : each of the lower brachials supports two others upon the upper sloping sides; and from each of these originates an arm, making twenty altogether.

ARMS composed at base of two thick plates, succeeded by about four wedgeform plates; and above this an alternating series of interlocking plates, which are furnished on their outer margins with jointed tentacula. Tentacula undetermined.

COLUMN large, consisting of alternating thicker and thinner joints.

This beautiful species is figured and described from a mould in sandstone, and from detached plates and fragments of columns. It belongs to the type having simple arms like *M. plumosus* and *M. spinulosus*, and is the finest species of the group. There is some obscurity in structure about the bases of the arms, but the representation is essentially correct. Each third radial supports two first brachial plates, and these each in turn two others, from which originate the simple arms; giving twenty arms, as in the other species of this group. The portions of the arms remaining are more than three times as long as the body, and probably they were originally at least four times as long as the body.

Fig. 1. The specimen, natural size, preserving the body, and on one side a part of the arms and a portion of the column.

Fig. 1 a. Diagram illustrating the structure from the base to the lower part of the arms (for comparison with structure of *Mariacrinus pachydactylus* and *M. plumosus*, plate iii).

Fig. 2 & 3. Fragments of columns apparently of this species.

Fig. 4. Section of column fig. 3.

Geological position and locality. In the Oriskany sandstone : Cumberland, Md.

Mariacrinus (Subgenus) **Technocrinus striatus** (n. s.).

PLATE LXXXVI. FIG. 12 & 5 – 11.

BODY unknown. Surface of plates marked by strong elevated striæ, diverging from the centre. Basal plates four, wider than long, small. First radial plates wider than high.

COLUMN small.

This species is founded on the base and first radial plates, and numerous separated plates of the same character. The surface markings are not unlike those of *Technocrinus andrewsi*, but are finer, the column and base proportionally much smaller, and the first radial plates proportionally shorter.

Fig. 12. The basal plates anchylosed together with a small portion of the column attached, and also one first radial plate.

Fig. 5, 6, 7, 9, 10 & 11. Several plates of different series belonging to this species.

Geological position and locality. In the Oriskany sandstone : Cumberland, Md.

Mariacrinus (Subgenus) **Technocrinus sculptus** (n. s.).

PLATE LXXXVI. FIG. 13 & 14.

BODY unknown. Base urn-shaped, gradully expanding above, abruptly expanded at the junction of the column : cavity for the insertion of the column large. Basal plates marked by strong sharp ridges, which diverge from the base to the upper margins, and unite upon the lines in the direction from the angles to the base of the plates.

The strongly sculptured markings of the plates, and the form of the base, will serve to distinguish this species from any other at present known to me. Two other specimens have been found, each preserving similar characters. There are likewise a few large plates and some fragments of columns which may belong to this species.

Fig. 13 & 14. Basal and lateral view of the lower part of the body.

Geological position and locality. In the Oriskany sandstone, Cumberland, Md.

Edriocrinus sacculus (n. s.).

PLATE LXXXVII. FIG. 1 – 22.

BODY more or less obconic or turbinate below and cylindrical above, varying in its proportions of length and breadth. Base varying in form from turbinate to hemispheric, solid, often obliquely truncate or indented below : upper margin marked by six subangularly concave depressions for the insertion of the radial and anal plates. Radial plates large, longer than wide, inserted into the depressions in the margin of the base, gradually expanding towards the upper margin which is thickened externally, slightly concave for the reception of the plates of the arm.

ARMS broad at the base, composed of numerous very short transversely linear plates, of which ten or twelve or more occur below the first bifurcation : first bifurcation in the middle, and each side again bifurcating on the third or fourth plate above, with each division bifurcating once or twice beyond this; making eight or ten or more divisions at the extremities. Anal plates two, the lower large and of the same form as the radial plates; the second one small and short.

PROBOSCIS and summit unknown.

COLUMN none : affixed to foreign bodies by the solid base.

This remarkable crinoid is extremely variable in the form of the basal portion, which is the part usually preserved. It may be indeed that more than one species are included among the forms illustrated, but I have not at this time the means of satisfactory discrimination.

In its earlier stages of growth, the base of this crinoid appears as a short pedicle attached to shells and other foreign bodies, the radial plates proceeding from it as from the summit of a column. It occurs singly or in groups of two or three, as shown in figures 1, 2 and 3. In its successive stages, it appears with a truncated base more or less rounded, but still preserving the marks of its former adhesion as in figures 4, 5, 6, 7 and 8 : fig. 8 shows the radial plates and the first plates of the arms, with a portion of one arm. The basal portion presents forms varying from elongate turbinate to hemispheric, exhibiting a great variety of modifications and distortions.

This species differs from the one in the Lower Helderberg group mainly in its larger size; the summit of the base having a diameter of an inch or more, with a length of from one to two inches.

Fig. 1, 2, 3. The young growing singly and in groups of two and three, preserving the radial plates above the base, which is still expanded below at its point of adhesion.

Fig. 4, 5, 6, 7. The bases of several individuals, showing the marks of adhesion below, and having forms more or less elongated and slightly distorted.

Fig. 8. The base, still showing the mark of adhesion at the base, and preserving the radial plates with portions of the arms.

Fig. 9. The base entirely rounded, and with the radials and first arm-plates attached.

Fig. 10. An individual nearly entire, having a part of the base broken off, but preserving the radial plates with the arms more or less entire.

Fig. 11. Diagram of the structure, showing the base, radial and anal plates, and first plates of the arms.

Fig. 12, 13, 14 & 15. Lateral and interior views of two very symmetrical bases of this species.

Fig. 16, 17 & 18. A specimen much elongated below, and one of nearly hemispheric form.

Fig. 19 & 20. Lateral and interior views of a remarkably elongated specimen, which may perhaps prove a distinct species.

Fig. 21 & 22. Lateral and basal view of a specimen presenting an appearance as if the the upper one had grown from the interior of the base of a preceding individual.

Geological position and locality. In the Oriskany sandstone : Cumberland, Md.

COLUMNS AND PLATES OF UNDETERMINED CRINOIDEÆ.

PLATE LXXXV. FIG. 19 – 23.

Fragments of large columns, with thick nodiferous joints separated by three smaller joints, the middle one of which is broader and thicker than the one on each side, are common in the sandstone : they probably belong to a species of the Subgenus *Technocrinus*.

The illustrations are of fragments which are marked by a deep concavity on the extremities, and a small round canal, as seen in fig. 20; but not unfrequently presenting the appearance of a very large canal, from the removal of the thin central portion of the plate, as in the remaining figures 19, 22 and 23.

A single plate (fig. 5 of Plate LXXXVI) belongs to a species of crinoid distinct from any here described : it is probably of the Subgenus *Technocrinus*, with the radiating lines much finer than either of the others.

Geological position and locality. In the Oriskany sandstone, Cumberland, Md.

CYSTIDEÆ OF THE ORISKANY SANDSTONE.

Anomalocystites disparilis (n. s.).

PLATE LXXXVIII. FIG. 1 – 4.

BODY longitudinally subelliptical in outline (when viewed from the anterior or posterior direction), concavo-convex, with the margins strongly angular. Basal plates, or plates of the first series, on the concave side, two, somewhat triangular and strongly curvilinear, together giving a deep crescent-form outline to the base ; on the convex side, three plates. Second range on the concave side, a single large plate which is slightly curved on the lower side ; the lower angles truncate and the sides vertical, one longer than the other, and unequally indented above for the reception of two plates, and on the upper lefthand angle for the reception of an irregular plate. Third range consisting of three plates. Fourth range unknown. Convex or posteal side above the basal plates composed somewhat irregularly of six ranges of plates, having 3+4(5?)+5+4+4 plates respectively ; above which the structure is unknown. Lateral or radial plates three known on each side in direct succession, the lower

one elongated and very unequally five-sided; the lower angular extremity resting one side against the long basal plate of the concave side, and the opposite shorter side resting upon the sloping edge of the adjoining basal plate of the convex side. The second radial plates rest, one side against the lateral margins of the large central plate of the concave side, and the opposite sides adjoin the plates of the convex side; thus, with the base and summit, giving one of those plates an irregular hexagonal and the other a heptagonal form. Third radial or angular plates heptagonal. Fourth radials unknown.

COLUMN unknown.

This very anomalous form does not correspond in structure with any described species of cystidian or crinoid. The body is in form like some of the ovoid cystidians or crinoids cut longitudinally through the centre; and a little depressed on that side, with strong bent plates at the angles. The arrangement is distinctly in four series; the two lateral or angular plates corresponding, while the posteal and anteal series are very unlike in form, number and arrangement. The summit is broken off; so that the organs of mouth, ovarian opening, etc., remain undetermined. There are three plates preserved in each lateral series; and there was evidently a fourth, which probably supported spines similar to those observed in the other species, and which seem to be the only representation of arms or tentacula in this form of cystidian.

The specimen figured has suffered no distortion, and the figures represent no more of the structure than can be seen distinctly. The basal range of plates on the posteal side are only partially preserved, and are described in part from the form of the spaces remaining, and from the corresponding parts in the other species where well preserved.

Fig. 1. Anteal or concave side, showing the deeply arched or crescentform base with the succeeding plates.

Fig. 2. Posteal or convex side, showing form and arrangement of plates.

Fig. 3. Lateral view of the same specimen.

Fig. 4. Diagram illustrating the structure of the body, showing the deep indentation for the insertion of the column : *a*, plates of the anteal or concave side ; *p*, plates of the posteal or convex side ; *r*, *r*, the lateral or radial plates, which are shaded to indicate the abrupt angles, one part of the plate serving to make up the convex and the other the concave side.

Geological position and locality. In the Oriskany sandstone : Cumberland, Md.

PLATES OF UNDETERMINED CRINOIDIAN OR CYSTIDIAN BODIES.

PLATE LXXXVIII. FIG. 5 – 9.

The specimens are thickened hexagonal or irregular plates, with margins indicating a suture-like junction with other plates or some other similar body : they have all a cicatrix upon the centre of the inner side. The surface aspect and texture do not differ from plates of *Edriocrinus;* but with our present knowledge of that fossil, these could only be referred conjecturally to the summit of the known species, or possibly are the free bases of a similar form.

ADDENDA.

Mariacrinus ramosus (n. s.).

PLATE II. FIG. 2 & 3.

BODY urnshaped. Basal or pelvic plates small. Radial plates longer than wide. Arm-plates two, resting on the upper sloping edges of the third radial, producing a double series, which again bifurcate on the third brachial plate above, giving origin to two pairs of arms ; the two inner or adjoining arms similar, and the two outer arms similar to each other. The central pair of arms bifurcate irregularly at least three times above the separation ; each branch above the last bifurcation being composed of a double series of wedgeform plates, and below these points of a simple series of quadrangular plates. The lateral arms remain simple. Tentacula round, apparently furnished with a second series of tentacles. Surface of plates marked by strong radiating ridges.

This species presents another modification of the arm structure, intermediate to that of *M. nobilissimus* and that of *M. plumosus*. The lateral arms of each double pair, or those proceeding from each radial series, represent the auxiliary arms of *M. nobilissimus*, *M. pachydactylus*, etc., while the central pair represent the large or principal arm of that species; the bifurcations being analogous to the armlets of those species. The modifications of structure affect only the arms : the body and base of arms are composed as in those species.

Fig. 2. The specimen, natural size.

Fig. 3. Diagram of structure, showing relations of radial series to arms, etc.

Geological position and locality. Same as *M. nobilissimus*.

NOTE. I am indebted to LEDYARD LINCKLAEN, esquire, for the magnificent specimen of the most beautiful species of this genus, *Mariacrinus nobilissimus*, figured on Plate II. The large specimen figured on Plate II A was obligingly lent to me by Col. E. JEWETT.

PLATYCRINUS *plumosus*. I should have noticed in its proper place the close resemblance between this species and *Marsupiocrinus cælatus*, MURCHISON, Sil. System, pa. 672, pl. 18, f. 3; also Siluria, pl. 14, f. 1; and woodcut p. 219, f. 1, 2 & 3, the latter illustrating entire individuals and parts. We are not informed, however, whether these later discoveries demonstrate the original supposition of Professor PHILLIPS, that the species has five pelvic plates. The original description is "pelvic plates unknown (probably five)." From the remarkable analogy in all the superior parts of *Marsupiocrinites cælatus* with *Platycrinus plumosus*, I cannot avoid the presumption that the British species is a true *Platycrinus*, as is ours; having a very small base, with the sutures of the three plates faintly visible, but still leaving no doubt as to its true reference.

The analogy is the more interesting, since the two forms are from rocks which are regarded as occupying very nearly the same geological horizon in the two countries. Should it be found that the analogy in the entire structure is as close as the general resemblance and structure of the upper portions of the body and arms, it will prove the occurrence of *Platycrinus* in Great Britain, as in the United States, during the Upper Silurian period.

DICTYOCRINUS. Under this genus I omitted to remark upon its supposed relations with *Ischadites* of MURCHISON, Sil. System, pa. 697, pl. 26, f. 11. Indeed the figures in the Silurian System bear so close a resemblance to *Receptaculites*, that I could scarcely regard them as distinct from that genus. Mr. MORRIS, in his Catalogue of British Fossils, cites *Ischadites kœnigi* as synonymous with *Receptaculites neptuni*. The figures given by Dr. D. D. OWEN in his Report of Explorations of Iowa, Wisconsin and Illinois in 1844, pl. 18, f. 7, as *Orbitulites? reticulata*; and in his Geological Report of Iowa, Wisconsin and Minnesota, 1850, pl. 2 B, f. 13, as *Selenoides iowensis*, bear a close resemblance to the figures of *Ischadites*. The Illinois and Iowa specimens cited above have all the characters of *Receptaculites*, and do not appear to me to be related to *Dictyocrinus*. At the same time I have observed some specimens in the Schoharie grit of New-York, which, having the general aspect of *Receptaculites* in the form and arrangement of the cells or divisions of the surface, have been furnished with a pedicle precisely as in *Dictyocrinus*. The substance of the fossil has, however, been removed; and from those portions remaining, it is not easy to determine positively their relations.

The Genus *Tetragonis*, proposed by EICHWALD in 1842 for a silurian fossil, having as he thinks some relation to *Ischadites* of MURCHISON, may perhaps include forms like *Dictyocrinus*; but if the fossil described and figured by Profssor M'COY in his Descriptions of the British Palæozoic Fossils in the Museum at Cambridge, pa. 62, pl. 1 D, f. 7 & 8, be a true *Tetragonis*, I would hesitate to include under that designation either *Ischadites* or *Dictyocrinus*.

With the materials at present possessed, I can express no satisfactory opinion as to the relations of *Dictyocrinus*; but I can scarcely regard it as a cystidian, and I am quite satisfied that it has no relations with *Receptaculites*, or with the bodies figured by Dr. OWEN as above cited, which I regard as belonging to the Genus *Receptaculites*.

FURTHER OBSERVATIONS ON THE CYSTIDEÆ.

THE Memoir of VON BUCH "*Über Cystideen*", published in 1845, giving the result of his researches upon the structure and relations of these fossil bodies, created a new interest in the subject of his philosophical investigations. Although these bodies had long been known, and several species described by various authors, their zoological affinities and relations had not been clearly indicated; and no attempt had been made to separate them as a group from the Crinoideæ, until WAHLENBERG in 1821 suggested that they were animals intermediate to the Sea-urchins, Echinideæ and Crinoids. This writer describes, under the name *Echinosphærites*, three species which had previously been described as *Echinus* by GYLLENHAL and HISINGER.

M. VON BUCH has advanced the opinion that these bodies constitute a distinct order of Echinodermata, inferior to the Crinoids; and this view has been followed by M. DE VERNEUIL, while VOLBORTH, PICTET, and others have maintained that they are true Crinoids.

Prof. EDWARD FORBES, in his Memoir upon the Cystideæ of the Silurian rocks of the British islands (Memoirs of the Geol. Survey, Vol. ii, part ii, 1848), maintains the opinion first advanced by WAHLENBERG regarding the relations of these bodies; presenting a very interesting and philosophical essay upon the subject, which has been more fully noticed in the second volume of the Palæontology of New-York.

Without intending in this place any discussion of the question of the relations of these fossils, it may be interesting to notice the progress of our knowledge regarding them, and the additional genera and species which have been published since the date of the Memoir of VON BUCH.

In this memoir five genera are described, viz: *Hemicosmites*, *Cryptocrinites*, *Caryocystites*, *Echinoencrinites* (= *Sycocystites*), and *Echinosphærites* (= *Sphæronites*). Prof. FORBES, in his memoir cited, has added *Apiocystites*, *Pseudocrinites*, *Prunocystites* and *Agelacrinus*. In the second volume of the Palæontology of New-York there have been added *Callocystites*, *Hemi-*

cystites (and *Heterocystites*, which is possibly a crinoid). In the present volume are added *Lepadocrinus*, *Sphærocystites*, and *Anomalocystites*.

Mr. BILLINGS, of the Canada Geological Survey, has described in his Report, now in press, *Glyptocystites*, *Pleurocystites* and *Malocystites*, from the Lower Silurian rocks.

The following notice of the principal genera of Cystidians at present known, with some of their leading characteristics, may not be uninteresting in this place.

HEMICOSMITES (Von Buch, 1840). Body composed of four series or ranges of plates: basal plates four, two narrow pentagonal and two broad hexagonal; second series, six plates; third series, nine plates; fourth, or supraovarian series, eight plates. Ovarian pyramid five-valved: mouth central. Arms none.

This genus is interesting from its relations with *Caryocrinus;* and forms, with that genus, a well-marked passage from the Crinoideæ to the Cystideæ.

H. pyriformis, *H.? oblongus* and *H.? squamosus* are Lower Silurian species.

CARYOCYSTITES (Von Buch). Body spheroidal or irregular, composed of five ranges of plates; the base having four, of which two are large and two small.

This genus is by some palæontologists included under *Echinosphærites*, and differs mainly in the less number and definite order of arrangement of the plates.

C. davisi, *C. granatum*, *C. litchi*, *C.? munitus*, *C. pyriformis*, are Lower Silurian species.

ECHINOSPHÆRITES (Wahlenberg, 1821); SPHÆRONITES (Hisinger, 1837). Body spherical, composed of a great number of plates, which are irregularly disposed: basal plates six. Oral and anal orifice at the summit. Ovarian orifice on the postero-lateral portion of the upper hemisphere of the body, in a line with the mouth. Arms none. Surface of plates striated with ridges radiating from the centres of the plates.

E. arachnoides, *E. aurantium*, *E. balticus*, *E. pomum*, *E.? punctatus*, *E. tessellatus:* these are all Lower Silurian species, with the exception of *E. tessellatus* of PHILLIPS. One or more species of this genus have been found abundantly in Canada. The specimens from Escanaba river, described by the writer, belong probably to this genus.

CRYPTOCRINITES (Von Buch). Body rotund, subhemispherical, composed of three ranges of plates: basal plates three; second series five; third series (according to VON BUCH) five.

C. lævis: a Lower Silurian species.

ECHINOENCRINITES (Von Meyer) ; [SYCOCYSTITES (Von Buch) ; GONOCRINUS (Eichwald) ; ECHINOSPHÆRITES (Pander)]. Body ovoid, often subangular, bearing pectinated rhombs. Basal plates four, with three succeeding ranges of five each.

The principal species published are *E. angulosus*, *E. anatiformis*, *E. armatus*, *E. baccatus*, *E. fenestratus*, *E. giganteus*, *E. seckenbergi*, *E. striatus ;* and several new species to be described in the forthcoming Reports of the Canadian Geological Survey. There is one undescribed species from the Hudson-river group. All of Lower and Upper Silurian age.

GLYPTOCYSTITES (Billings). Body composed of four ranges of plates : basal plates four; higher ranges five, with arms attached, and numerous pectinated rhombs.

This last character is the distinguishing feature of the genus; as these pore areas, or pectinated rhombs, in other genera are three, or in three double or contiguous spaces.

Species *ined.* Lower Silurian.

PRUNOCYSTITES (Forbes). Body ovoid : basal plates four; second and third series five plates each ; upper or apicial series unknown. Oral tentacles and pectinated rhombs.

P. fletcheri : Upper Silurian.

PSEUDOCRINITES (Pearce, 1842; Forbes, 1848). Body ovoid, composed of four ranges of plates, with an undetermined apicial range. Basal plates four, with three succeeding ranges of five each ; bearing pectinated rhombs, and arms with tentacles.

P. bifasciatus, *P. magnificus*, *P. oblongus*, *P. quadrifasciatus :* Upper Silurian species.

APIOCYSTITES (Forbes). Structure as in *Pseudocrinites.*

A. pentremitoides, *A. elegans :* Upper Silurian.

LEPADOCRINUS (Conrad). Structure essentially as *Apiocystites* and *Pseudocrinites.*

L. gebhardi : Upper Silurian.

SPHÆROCYSTITES (Hall). Body spheroidal : base composed of four plates; upper series unknown. Ovarian orifice superior. Arms numerous. Pectinated rhombs as in preceding genera.

S. multifasciatus : Upper Silurian.

CALLOCYSTITES (Hall). Body ovoid : basal plates four; second series eight; third series eight? Apicial plates undetermined. Arms and pectinated rhombs as in three preceding genera.

C. jewetti : Upper Silurian.

PLEUROCYSTITES (Billings). Body inequilateral : basal plates six; one side composed of large plates, the other of small plates. Apicial range bearing two arms.

There appears to be some analogy between this genus and *Anomalocystites*.

Several species : Lower Silurian.

MALOCYSTITES (Billings). Allied to *Cryptocrinus*. Basal plates three, with several ranges of superior plates.

Lower Silurian.

ANOMALOCYSTITES (Hall, p. 132).

A. cornutus, *A. disparilis* : Upper Silurian.

AGELACRINUS (Vanuxem, 1842 ; Forbes, 1848). Mr. FORBES describes the *Agelacrinus* as a many-plated body, having fine serpentine grooves radiating from the mouth, in which lie the appressed arms. Ovarian pyramid in one of the spaces between the arms.

A. hamiltonensis, *A. buchianus* : Devonian and Lower Silurian.

HEMICYSTITES (Hall). Body flattened, composed of imbricating scale-like plates : five double ranges of elevated plates proceed from the centre towards the margins, in the broadest space between which is placed the ovarian aperture. Attached to other bodies.

This genus has been usually referred to *Agelacrinus*, but it does not correspond with that genus as described by FORBES. Other species may perhaps show that the Lower Silurian, Upper Silurian, and Devonian forms can be united in a single genus.

H. parasiticus.

HETEROCYSTITES (Hall). Basal plates four ; second range ten, with intercalated smaller plates, and, above this, numerous smaller plates.

The relations of this fossil have not been fully determined ; but from the irregularity of its plates, it does not appear referable to the Crinoideæ.

H. armatus : Upper Silurian.

BRACHIOPODA OF THE LOWER HELDERBERG GROUP.

THE general resemblance of the Brachiopoda of this period to those of the Niagara group is at once observed upon comparing collections from the two groups : indeed so similar are many of the species of the Lower Helderberg rocks to those of the Niagara group, that they are regarded by many palæontologists as identical. A careful comparison, however, leaves much doubt whether even a single species has been found which is common to the two periods. Almost every species of the Niagara group is represented in the Lower Helderberg, not only by a similar species, in general terms, but in the form, sculpture or surface markings, and external aspects; and often to a great extent in internal characters, they approach each other very nearly; and not only is this so, but often we find in the Lower Helderberg two or more analogues of a single Niagara species. This is true of the ORTHIS, where *O. elegantula* of the Niagara group is represented by *O. subcarinata* and *O. perelegans; O. hybrida*, by *O. oblata* and *O. discus*, a smaller form; and *O. punctostriata*, by *O. tubulostriata. Spirifer niagarensis* is represented by *S. macropleura; S. sulcata*, by *S. perlamellosa; S. crispus*, by *S. cycloptera;* and *Strophomena subplana*, by *S. woolworthana.* The same comparisons may be made of the *Rhynchonellæ. Pentamerus fornicatus* of the Clinton group is represented by *P. galeatus;* and *P.* (*Atrypa*) *interplicata*, a true *Pentamerus*, is represented in the Lower Helderberg by *P. verneuili.*

I might go much farther in these comparisons, showing how very complete is the representation of the Niagara brachiopod fauna in the Lower Helderberg group, and particularly in the shaly limestone, where the physical conditions are so similar to those of the shales of the Niagara group.

Indeed were we to select these analogous forms alone, and present them side by side with the brachiopods of the Niagara group, an experienced palæontologist might well hesitate in regarding them as distinct species,

and might consider whether these apparently similar forms were ... to different physical conditions existing in distant parts of the ocean of the same period, which had given a fuller development to those species which in the Niagara group are always smaller than in the Lower Helderberg group.

Nevertheless it should not be overlooked, that, mingled with these analogous forms of the same genera, and occurring in materials which indicate the same physical conditions, there are other genera in the Lower Helderberg group which are quite unknown in the Niagara period. We have here appearing for the first time the genera WALDHEIMIA? MEGANTERIS, EATONIA, etc.; while STROPHODONTA, which had scarcely an existence in the Niagara period, becomes numerously developed. The Genus MERISTA, which is represented by few species in the Niagara period, becomes conspicuous in the successive beds of the Lower Helderberg period.

I have before (Palæontology N. Y. Vol. ii, p. 249) spoken of the apparent identity in age of the Niagara group of the United States, with the Wenlock formation of Great Britain; and of the incompleteness in the palæozoic analogues, which are only filled by those of the Lower Helderberg group. The illustrations of the present volume will therefore furnish the means for a comparison not heretofore existing in published records.

I have also shown that in a southwesterly direction the rocks of the Niagara and Lower Helderberg periods approach each other more closely, so that in Tennessee they appear to be inseparable, and the fossils of the two groups are collected within the space of thirty feet in thickness from what appear to be the same beds. It is quite probable, therefore, that this palæozoic ocean, which, to the north and northwest was invaded by the materials forming the Onondaga-salt group, and which is for the most part destitute of organic remains, continued undisturbed at the southwest; and that the faunas of the Niagara and Lower Helderberg groups, which are here separated by the great marl and calcareous deposit of the Onondaga-salt group, then succeeded each other upon the same ocean

bed without the intervention of these sediments. These faunas, as they occur in the southwest in the same group of beds, may be as distinct in the order of time as those which are separated from each other by a thousand feet in thickness of other deposits.

This example of the apparent mingling in the same group of the faunas of two distinct periods, is only one among numerous others that have been observed among the different groups constituting the Silurian, Devonian and Carboniferous systems. We shall have occasion to notice similar features between the Lower and Upper Helderberg groups in the absence of the Oriskany sandstone, and between the Hamilton and Chemung groups, as also between these groups and the rocks of the Carboniferous system.

Lingula centrilineata (n. s.).

PLATE IX. FIG. 1, 2.

SHELL oval-ovate, about once and a half as long as wide : beak obtuse : base rounded, greatest width central or a little below the centre, very little convex.

SURFACE marked by concentric lines of growth and finer lamellose concentric striæ, which are nearly obliterated by the exfoliation of the outer shell, when the surface presents fine parallel longitudinal striæ and a central impressed line from beak to base.

The characterizing features in this species, as far as can be observed, are the central line reaching from the beak quite to the base, and the very equidistant lamellose striæ upon the exterior shell, which make a shorter curve than the concentric striæ of growth (these are not well shown in the figure). On the exfoliated surface, the concentric striæ are very faint or altogether obsolete.

Fig. 1. A small individual of this species.

Fig. 2. A larger specimen of the same.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains, Albany county.

Lingula perlata (n. s.).

PLATE IX. FIG. 3 – 5.

SHELL ovate : beaks subacute : base broadly rounded, having the greatest width a little below the centre. Valves equally convex.

SURFACE marked by close concentric lines of growth, the impression of which is preserved when the outer shell is removed. Exfoliated surface marked by faint concentric ridges, corresponding to those on the exterior, and fine scarcely visible longitudinal striæ.

In the specimen fig. 4, the striæ are generally very closely arranged; though certain portions of the surface present these markings comparatively distant, dependent doubtless on the rate of growth in the shell.

In the specimen fig. 5, the striæ on the upper part of the shell are distant three or four times their width, while those on the lower part are close together. These variations, and the want of perfect agreement in the surface characters, are scarcely of specific value; and without a larger number of specimens, it would be unwise to make distinctions.

Fig. 4. An individual of medium size, preserving the two valves. The outer shell is partially exfoliated from the central part of the valve.

Fig. 3. Profile of the same specimen, showing the convexity of the valves.

Fig. 5. The lower part of a larger valve having the striæ more distant, very thin and sharply elevated, while towards the margin they are more closely arranged.

Fig. 5 *a*. Enlargement of the concentric lamellæ.

Geological position and locality. In the Pentamerus limestone (specimen no. 5), and in the shaly limestone of the Lower Helderberg group : Albany and Schoharie counties.

Lingula rectilatera (n. s.).

PLATE IX. FIG. 6 & 8.

SHELL subelliptical : sides parallel, abruptly curving towards the base and beak : base abruptly rounded or subtruncate. Cardinal margins nearly straight, very convex in the middle and subobtusely carinate towards the beak, which sometimes extends a little beyond the body of the shell in an acute point.

Lingula spatiosa (n. s.).

PLATE IX. FIG. 10 & 10 *a*.

SHELL broadly ovate, with beak acute, base broadly rounded, and sides sloping in a gentle curve to the beak. Length a little greater than the greatest breadth, which is at a point less than one-third the length from the base.

SURFACE, which is partially exfoliated, marked by fine equidistant concentric lines, crossed by fine scarcely perceptible radiating lines (these lines are much too strong in the figure).

Fig. 10. The shell, natural size.

Fig. 10 *a*. A portion of the surface enlarged.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Becraft's mountain near Hudson.

In certain parts of the shaly limestone in the Lower Helderberg group in Albany county, the lingulæ are common fossils, occurring often in fragments, and not unfrequently in the centre of phosphatic nodules which have all the external aspect of coprolites. These masses sometimes contain a single shell of *Lingula* in the centre, with few or no fragments of similar shells in the surrounding mass; while others are composed of fragments of shells of lingulæ with intermediate dark-colored impure carbonate of lime, which effervesces very slowly in acid. These bodies may probably be concretions where phosphatic material has aggregated around the *Lingula*, or a similar mass when fragments of these shells have formed the nucleus. The uniformly elongate oval or ovoid form, and usually vertical position in the strata, are remarkable and interesting features. A chemical analysis may perhaps furnish some information suggestive of their origin.

GENUS DISCINA (LAMARCK).

Discina : LAMARCK, 1819, Hist. Nat. des Animaux sans vertebres.
Orbicula of authors, not of CUVIER and LAMARCK.

The fossil shells usually referred to *Orbicula* by authors, are very properly arranged, by Dr. J. E. GRAY, Prof. FLEMING, Prof. KING, Prof. M'COY, and Mr. DAVIDSON, under the Genus *Discina*, a name proposed by LAMARCK for a recent species, the *Discina* (*Orbicula*) *lamellosa* of authors. The term *Orbicula* was originally used by CUVIER and LAMARCK to designate a recent species, which is known to belong to the Genus *Crania**.

The following are some of the exterior characters of the shells of this genus, as given by Mr. DAVIDSON :

"Circular, longitudinally or transversely oval. Upper or dorsal valve conical, patelliform, with the apex inclining towards the posterior margin. Lower or ventral valve opercular, flat or partly convex, and perforated by a narrow oval longitudinal slit, reaching to near the posterior margin, and placed in the middle of an oval depressed disk.

"SURFACE smooth, ornamented by numerous striæ radiating from the apex to the margin, or by concentric lines of growth produced in foliaceous expansions. Shell structure horny, and perforated by minute tubuli."

Discina discus (n. s.).

PLATE IX. FIG. 13 – 15.

Compare *Discina* (*Orbicula*) *forbesii*, DAVIDSON, Bull. Soc. Géol. France, Deuxième Série, Tome v, pa. 334, pl. 3, f. 45.
Memoirs Geol. Survey of Great Britain, Vol. ii, Part i, pa. 321, pl. 26, f. 2.

SHELL orbicular, rarely subelliptical in form. Upper or dorsal valve moderately convex : apex nearly central. Lower or ventral valve nearly

* See : DAVIDSON, Introduction to the Classification of the Brachiopoda.
Dr. GRAY, Annals of Philosophy, New Series, Vol. x, 1825; Ann. and Mag. Nat. History, Vol. ii, Second Series, p. 349.
Prof. KING, Monograph of Permian Fossils, p. 84, 1849.
M'COY, British Pal. Fossils in Cambridge Museum, 1852, p. 190, etc.

flat : apex rising a little in front of the foramen, and concave between this point and the anterior margin. Depression of the surface at the foramen round or round-oval; the slit oval or acute at the extremity. SURFACE marked by strong concentric lamellose striæ, and finer closely arranged radiating striæ. Shell, when exfoliated, showing radiating striæ. Interior of shell with distant strong radiating striæ, simple or fasciculate, and vascular impressions strongly marked.

The specimens of this fossil are usually quite orbicular, and the deviations from that form may be due to distortion. When not exfoliated, the surface is marked by strong lamellose nearly equidistant concentric striæ, and very fine closely arranged radiating striæ. Few specimens, however, preserve these characters in perfection. Exfoliation destroys the finer striæ, while the concentric lines are still preserved; and a yet further exfoliation reveals another set of radiating striæ, which are more or less connected with the vascular impressions. In fig. 14 of the plate, these radiating striæ are represented as much too regular and rectilinear in their arrangement.

This species bears some resemblance to *D. forbesi*; but the lamellose striæ are finer, and the foramen is longer and narrower, according to the figures in the Memoirs of the Geological Survey of Great Britain, while the figures of Mr. DAVIDSON represent the apex of the lower valve as much more excentric than in our specimens.

Fig. 13. The lower valve partially exfoliated, and showing radiating striæ.

Fig. 14. Interior of the lower or ventral valve, showing the lamellose structure and radiating striæ. [In the figure the striæ are too regular, and should be represented as bifurcating towards the margin.]

Fig. 15. A lower valve (with the margins slightly exfoliated), preserving nearly entire the concentric lamellose striæ.

Fig. 16 *a* (Error for 15 *a*). Profile of the lower valve, showing the convexity.

Fig. 15 *b*. Enlargement of the lamellose striæ.

Fig. 15 *a* (Error for 14 *a*). Enlargement of the radiating striæ of fig. 14.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Becraft's mountain near Hudson.

Discina conradi (n. s.).

Compare *Discina* (*Orbicula*) *verneuili*, DAVIDSON, Bull. Soc. Géol. de France, Deuxième Série, Tome v, pa. 334, pl. 3, f. 48.

PLATE IX. FIG. 16, 17 & 17 *a*; and PLATE X A. FIG. 2 *a*, *b*.

SHELL orbicular. Dorsal valve very convex, gibbous and obtuse, with the apex a little inclined towards the posterior margin, and distant from it about one-third the width of the shell. Ventral valve flat or slightly concave : foramen submarginal.

SURFACE marked by regular distinct radiating striæ or ridges, with finer concentric striæ.

This species differs from the preceding in the absence of the strong lamellose concentric striæ, and the stronger radiating striæ. The dorsal valve is much more convex than in that species; and the ventral valve is concave, and not elevated at the apex, while the foramen is near the margin. In single crushed and distorted valves there may be sometimes difficulty in distinguishing the species; though there are generally some remains of the strong lamellose striæ in *D. discus*, which I believe to be always reliable distinguishing characters among the specimens I have examined from the localities in New-York.

In its strong radiating striæ, this species resembles the *D. verneuili* of DAVIDSON, cited above; but the striæ are represented as coarser and more elevated, and the dorsal valve is less convex, while the beak is more nearly marginal.

The two species compared, viz. *D. forbesi* and *D. verneuili*, are from the Wenlock limestone of England, a geological series embracing, in different localities, species known both in our Niagara and Lower Helderberg groups.

Fig. 12. Exterior view of the lower valve (improperly represented without the foramen). See Plate, X A for corrected illustrations of this and the preceding species.

Fig. 16. Dorsal valve having the outer shell exfoliated, and showing radiating striæ which bifurcate towards the margins.

Fig. 17. Enlargement of the striæ.

Fig. 17 *a*. Profile view of the dorsal valve.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains, and Becraft's mountain near Hudson.

Discina vanuxemi (n. s.).

PLATE VIII. FIG. 1 *a*, *b*.

SHELL orbicular or broadly subelliptical. Dorsal valve very convex : apex excentric, and pointed towards the posterior extremity of the shell.

SURFACE marked by fine closely arranged concentric striæ and finer radiating striæ, exhibiting a finely cancellated appearance under a magnifier. Inferior valve unknown.

This species differs but little in form from *D. discus*. The dorsal valve is much more convex, the beak somewhat acute, and the concentric striæ more closely arranged.

A single individual only of the dorsal valve has been found, and I am unable therefore to speak of the variety it may exhibit when studied with more specimens.

Fig. 1. Profile view.

Fig. 1 *a*. Dorsal view, showing the form of the shell.

Fig. 1 *b*. Enlargement of surface, showing the radiating and concentric striæ (the latter are not strong enough in proportion to the others).

Geological position and locality. In the upper part of the Waterlime group : Quarry northwest of Manlius-square.

Orthis oblata (n. s.).

PLATE X. FIG. 1 – 22.

Compare *Orthis hybrida*, MURCHISON, Sil. System, p. 63, pl. 13, f. 11; also Pal. N.Y. Vol. ii.
" *Orthis orbicularis*, SOWERBY.
" *Orthis vanuxemi* of the Hamilton group, N.Y.

SHELL in the young state longitudinally subovate, and varying from circular to transversely oval in its stages of growth, resupinate. Ventral valve convex at the beak, flattened in the middle, and concave towards the front. Dorsal valve very convex in the middle and towards the beak : beaks of the two valves nearly equally elevated; that of the ventral valve pointed : area very small : foramen large.

SURFACE finely striated : striæ frequently bifurcating and curving towards the lateral and cardinal margins, concentrically marked by finer striæ

and stronger lines of growth, which are numerous in the older shells.

Internally the ventral valve is marked by a large foliate vascular impression : impressions of the adductor muscles rarely well preserved, except in the casts. Teeth prominent, and, when entire, rounded and thickened at their extremities. Dorsal valve with a prominent cardinal process and divergent brachial lamellæ : a central ridge, more or less prominent, extends from beneath the beak to near the base.

This species resembles *Orthis hybrida* of the Niagara group, but is much larger, with valves proportionally less convex, and never so straight in front : the area is likewise smaller and shorter. In the young state it is more elongated, the beak of the ventral valve more extended, and the surface more coarsely striated than in corresponding specimens of *O. hybrida*. The older shells become more circular and gradually less convex. The ventral valve is marked by a broad undefined depression down the centre, making the entire valve broadly concave from a little below the beak, and producing a sinuous outline in front. The dorsal valve maintains a generally uniform convexity, its greatest height being towards the beak.

In young and half-grown shells the length and height are nearly equal, while in older specimens the proportions of length and breadth are often as three to four. In old shells the striæ become less conspicuous and comparatively finer than in the young shells; and this appearance is sometimes exaggerated by the process of silicification, which has affected the greater number of the Helderberg specimens.

On comparing this with a similar species in the Hamilton group, we find the young more circular, and the beaks less prominent in that one than in the Helderberg species. The surface is likewise more finely striated; and the ventral valve, though sometimes concave, has never any mesial depression, and the margin is not sinuate. There are likewise other differences, which may be observed on careful comparison of specimens.

Fig. 1, 2, 3. Individuals showing a gradation of size, from the smallest recognized specimens of the species to the half-grown forms.

Fig. 4, 5, 6. Individuals illustrating a more elongate and more gibbous form, which seems scarcely separable from the others, but is still never found of larger size than fig. 6.

Fig. 7, 8, 9, 10. Individuals of larger dimensions ; the last being a full-grown specimen of the broad variety, one and three-fourths inches wide by one and a quarter long.

Fig. 11, 12, 13, 14. The interior of the ventral valves of several specimens, showing some variety in the vascular impressions.

Fig. 15, 16. The interior of the dorsal valves of the more elongate and gibbous forms.

Fig. 17, 18. The interior of the dorsal valves of the broad variety, the last having the dimensions of an inch and a half by an inch and a quarter.

In this specimen the cardinal process is much thickened and elevated, so as to fill the entire foramen of the opposite valve.

Fig. 19, 20. Casts of the ventral valve, showing the muscular and vascular impressions.

Fig. 21, 22. Casts of the dorsal valve, with impressions of the cardinal and brachial processes.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains; Schoharie, Carlisle, Cherryvalley, Catskill, Hudson, etc.

Orthis oblata, var. emarginata.

PLATE X A. FIG. 4 – 6.

Among the collections from the Lower Helderberg rocks of Cumberland, Maryland, there are numerous specimens of an *Orthis*, having the same general characters as *O. oblata*, but proportionally narrower and the beak more extended. The dorsal valve is very convex, and the ventral valve is marked by an undefined depression, which, beginning below the beak, gradually becomes wider and deeper, producing a deep sinuosity or emargination in front.

The vascular area of the ventral valve occupies a comparatively greater space than in shells of O. *oblata* from the Helderberg, and it is more elongated or triangular in form. In the dorsal valve, the double imprints of the adductor muscles are well preserved.

Fig. 4 *a*, *b*, *c*, *d*. Illustrations of the form and characters of this variety.

Fig. 5 *a*, *b*. Interior of the two valves.

Fig. 6 *a*, *b*. Cast of the ventral and dorsal valve.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Cumberland, Maryland.

Orthis discus (n. s.).

PLATE X A. FIG. 7 – 12.

SHELL circular : valves moderately and nearly equally convex. Dorsal valve flattened or slightly depressed in the centre near the beak, the depression becoming broader and undefined below the middle of the shell. Ventral valve regularly convex, becoming flattened towards the lateral and basal margins, sometimes a little elevated in the middle. Area narrow : length equal to or greater than half the width of the shell. Foramen large, usually filled with the trifid cardinal process.

SURFACE finely striated : striæ somewhat in fascicles, abruptly bending upwards towards the hinge line. Ventral valve with a small vascular impression.

This species has hitherto been confounded with the *O. oblata* ; but it differs in the larger hinge area, the equal convexity of the valves, the flattening of the dorsal valve in the middle, and the absence of a depression in the ventral valve, which leaves the margin straight : also the striæ appear to be somewhat coarser.

This latter character, together with the nearly equal valves, sometimes causes this species to be mistaken for *O. tubulostriata*.

Fig. 7, 8 *a*, *b*. Individuals of the smaller known forms of this species.

Fig. 9, 10. Individuals of larger size.

Fig. 11. Interior of the ventral valve.

Fig. 12. Cast of dorsal valve, probably of this species.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains; Hudson, Catskill.

Orthis tubulostriata (n. s.).

PLATE XI. FIG. 1 – 6.

SHELL circular : valves nearly equally convex, depressed near the margin. Ventral valve more prominent towards the beak, which is sharply incurved over the area : area narrow, and about half as long as the width of the shell.

SURFACE striated. Striæ somewhat tubular, prominent, fasciculate, increasing by implantation and bifurcation, extremely curved towards the margins, and presenting at somewhat regular intervals small tubular pore-like openings upon the surface : radiating striæ, when not worn, crossed by prominent concentric striæ, and, rarely, by stronger lines of growth.

Cardinal process of the dorsal valve large, and nearly filling the foramen : brachial processes long, slender and diverging. Area of the muscular impressions in the ventral valve not strongly defined.

This species is readily distinguished from the preceding, and from others of similar form in these strata, by the prominent fasciculate striæ in which the tubular openings are very conspicuous. It may be compared with *O. neglecta* of BARRANDE (Silurische Brachiopoden aus Bœhmen : Naturwissenschaftliche Abhandlungen, Tab. XI, f. 11); but the figures given by that author represent the area as very different. It is unlike any other form at present known to me in the Silurian rocks of the United States.

Fig. 1 – 4. Young individuals of this species.

Fig. 5, 6. Larger individuals. The two figures on each side of fig. 6 are enlargements of striæ, one without the tubular openings, and the other showing this character. The righthand figure shows the cardinal and brachial processes of the dorsal valve*.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains, Albany county.

* The letters of reference for the different figures of this and of the following species have been left out, through the inadvertence of the lithographer.

Orthis eminens (n. s.).

PLATE XI. FIG. 7 – 14.

SHELL circularly subquadrate, wider than high. Dorsal valve convex in the middle, and depressed almost equally towards the margins : beak rising but slightly above the hinge line, with a central depression which is lost before reaching the middle of the valve. Ventral valve very convex near the beak, flattened or depressed towards the base : beak very prominent, projecting much beyond the opposite valve, pointed and slightly incurved. Hinge line less than the width of the shell. Area large, extending nearly two-thirds the entire width of the shell : foramen large and high.

SURFACE finely striated, with frequent bifurcations; the striæ curving upwards to the hinge margin.

This species, without careful observation, may be confounded with *O. oblata*, which in its young and half-grown state has the beak much more prominent than in the older forms. The larger area and subangular hinge extremities of the present species are distinguishing features. The greatest width is below the centre of the shell; and the ventral valve, instead of being concave nearly to the beak, is convex from the beak to the centre of the shell, and becomes gradually flattened towards the margin, where it is sometimes depressed, giving a slight sinuosity to the front. The striæ are coarser than in *O. oblata*, and, under a lens, exhibit an irregular alternation of coarse and very fine striæ, the latter scarcely increasing in size towards the margin.

This is an extremely rare species.

Fig. 7 – 10. Young individuals.

Fig. 11 & 14 are referred with doubt to this species.

Fig. 12. Three views of the same specimen.

Fig. 13. Three views of a larger individual.

The specimens 12 and 13 are well-marked and characteristic forms of this species.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains, Schoharie and Carlisle.

Orthis planoconvexa (n. s.).

PLATE XII. FIG. 1 – 6.

SHELL plano-convex; outline somewhat circular or transversely oval: length and breadth about as ten to twelve. Dorsal valve nearly flat, slightly prominent near the beak on either side of the faint central depression, and quite flat towards the margins. Ventral valve convex, sometimes scarcely subangular towards the beak; greatest convexity a little above the middle of the shell, and thence sloping uniformly to the lateral and basal margins: beak small, acute, incurved. Area linear, its length greater than half the width of the shell. Striæ fasciculate, much curved upwards towards the cardinal and lateral margins.

This species resembles *O. testudinaria* in form; but the area is narrower, and the striæ are finer and less distinctly fasciculate: it is also less angular on the ventral valve, and the dorsal valve less sinuate. The cardinal process of the dorsal valve is much stronger, while the imprints of the adductor muscles are far less strongly marked.

In the characters of surface striæ, it is coarser than *O. elegantula*, and the ventral valve less convex. It more nearly resembles the succeeding species (*O. subcarinata*), but is more compressed, the carination of the one valve and the depression of the other being subdued, while the striæ are somewhat stronger, more distinctly fasciculate, and more abruptly curving upwards towards the cardinal extremities. The interior also shows characters sufficient to distinguish it. In the dorsal valve, the lamellæ bordering the muscular areas, which diverge abruptly, and then becoming almost obsolete, curve so as to enclose a broad oval space with a depressed line through the centre. This feature contrasts strongly with the prominent lamellæ bounding the muscular impressions in the dorsal valve of *O. subcarinata*. In the ventral valve the lamellæ are broadly divergent, and, becoming gradually obsolete, are nearly lost, and leave scarcely an impression in the cast. The imprint of the adductor muscles forms a small scar towards the upper part of the vascular area, as in *O. oblata* and shells of similar form.

A single comparison of the interior structure will at once determine the question of identity or difference among these closely allied forms.

Fig. 1 *a*, *b*, *c*. Views of small individuals of this species, from Maryland.

Fig. 2 *a*, *b*, *c*, & 3. Larger individuals, from New-York, showing the ventral and dorsal sides, profile and area.

Fig. 4. The interior of the dorsal valve of the smaller individuals.

Fig. 5. Interior of the ventral valve.

Fig. 6 *a*, *b*. Dorsal and ventral valves of a cast of the same species.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains, Albany county; and in the same position, and also in the Oriskany sandstone, Cumberland, Maryland.

Orthis subcarinata (n. s.).

PLATE XII. FIG. 7 – 21.

SHELL somewhat transversely oval, often nearly circular or quadrangular, plano-convex. Dorsal valve more or less flattened, with a distinct depression along the middle, which becomes wider towards the base, producing a sinus in the margin of the shell : beak scarcely rising above the hinge line. Ventral valve very convex, strongly elevated or subcarinate along the middle : beak small, incurved. Area narrow, linear, one-half to two-thirds the width of the shell. The depressed line along the middle of the dorsal valve, and the ridge upon the ventral valve, very frequently diverge from the central line, though the specimens do not appear to have suffered any distortion from pressure.

SURFACE finely striated : striæ curving upwards towards the lateral and cardinal margins, equal or alternating in size, and not unfrequently fasciculate; concentrically marked by strong lines of growth towards the margin, and, in well-preserved specimens, by fine striæ over the entire surface.

Interior of the dorsal valve with an obscurely double impression for the adductor muscles on each side of a low sharp elevation, with sides subparallel : cardinal process strong and bifid at the extremity, with each division bilobed; brachial processes strong, divergent; vascular impressions preserved in the cast. The ventral valve shows, beneath the beak, a strong triangular cavity, with an abrupt groove at each

side extending downwards below the muscular cavity, and from which diverge the vascular impressions.

The casts of the two valves preserve all the characters enumerated, and in a few instances the vascular impsessions are well preserved. The strength of the parts described is subject to some variation in different individuals, and from different conditions of preservation.

The smaller individuals bear much resemblance to *O. orbicularis*, as figured by BARRANDE (Silurische Brachiopoden aus Bœhmen, *ut citata*, Tab. XX, f. 6); but the beak is more incurved, and the muscular impression differs very essentially from the one given by BARRANDE.

Orthis tetragona of DE VERNEUIL, as figured in DUNKER & VON MEYER'S Palæontographica, pl. 37, f. 8, closely resembles some of the intermediate forms of this species; but the ventral valve is not sufficiently elevated, and the striæ appear to be finer than these.

The smaller individuals of this species have been mistaken for *O. perelegans*, to which it is closely related; but full-grown specimens have the dorsal valve more distinctly sinuate and much less convex, while the central angular elevation of the ventral valve is equally a distinctive character. Both these species have been referred indiscriminately to *O. elegantula*, from which they differ in many important characters. Among the Lower Silurian forms, this has its representative in *O. testudinaria*, but is a larger species, the striæ are finer and less distinctly fasciculate, and the internal differences are more striking than the exterior.

Fig. 7, 8 *a*, *b*, *c*. Views of young individuals.

Fig. 9, 10. Views of individuals which have a subquadrangular outline, with the dorsal valve deeply depressed in the centre and much elevated on each side, and the front margin strongly sinuate.

(These forms will perhaps prove specifically distinct from the following; but at present I shall consider them only as a variety, *O. quadrans*.)

Fig. 11, 12. Interior of the valves of the preceding variety.

Fig. 13, 14, 15. Individuals showing gradation in size, and some slight modification in proportions.

Fig. 16, 17. Full-grown individuals of this species.

Fig. 18. Interior of the ventral valve.

Fig. 19 *a*, *b*. Interior of the dorsal valve, showing the muscular and vascular impressions.

Fig. 20, 21 *a*, *b*, *c*. Ventral and dorsal views of casts, the vascular impressions, etc.

Geological position and locality. In the shaly limestone of the Lower Helderberg group: Helderberg mountains; Catskill, Schoharie.

Orthis perelegans (n. s.).

PLATE XIII. FIG. 4 – 12.

SHELL transversely oval : valves nearly equally convex. Dorsal valve subventricose, more or less depressed along the middle from near the beak to the front : beak small, little elevated above the hinge line. Ventral valve elevated along the middle from the beak towards the front, and sloping laterally : beak small, pointed, incurved, extending beyond that of the opposite valve. Cardinal margin generally sloping a little from the beaks, and rounding imperceptibly into the lateral margins. Area narrow, nearly half as long as the width of the shell. Foramen broad triangular, extending nearly to the apex of the beak.

SURFACE marked by fine irregular bifurcating longitudinal striæ, crossed by concentric lines of growth.

This species is chiefly distinguished from the last by its more ventricose dorsal valve, and by the hinge line sloping more from the beaks laterally, giving a gently curved instead of straight outline. The ventral valve, although strongly elevated in the centre towards the beak, is not subcarinate, as in the last; and this gibbosity is lost before reaching the base. Along the middle of the dorsal valve there is a broad undefined depression, which is more conspicuous in the upper part, from the beak half way to the base; below which point, it becomes scarcely marked as a distinguishing character of the shell. This feature, together with the convexity of the valves, contrasts strongly with the nearly flat valve and narrow mesial depression of *O. subcarinata*. The striæ of this species are often fasciculate; the stronger ones separated by three, four, five or six smaller ones, a feature scarcely perceptible in the other species.

The internal differences are still more conspicuous. The cavity beneath the beak of the ventral valve is longer than in the preceding, and less angular, and the central ridge more elevated; the whole merging gently into the shell below, without the abrupt and angular termination of *O. subcarinata*. This character is well shown both in the shell and in the cast (fig. 9 & 11).

The areas of muscular attachment in the dorsal valve are limited by a strong ridge continuous with the brachial processes, which, curving outwards and again inwards, enclose an oval space of varying proportions, through the centre of which extends a longitudinal ridge which divides and ramifies below the muscular area.

The cardinal process is small in young shells, thickened in older ones, and does not rise as high as the brachial processes. In the latter character this species contrasts with *O. subcarinata*, where the cardinal process rises above the brachial lamellæ.

In species so nearly allied as the two here indicated, every feature of the shell, and of its internal structure, requires careful comparison; and it may often occur that in a single character the two approach so nearly as to furnish no reliable means of separation, while the sum of the characters renders the distinction conspicuous.

Fig. 4 *a*, *b*, *c*, etc. Views of small individuals, which appear to be the young of this species, but may prove distinct.

Fig. 5 *a*, *b*, *c*. Small individuals, authentic forms of this species.

Fig. 6 *a*, *b*, *c*. Specimens intermediate in size.

Fig. 7 *a*, *b*. Specimens of the ordinary size.

Fig. 8. A large individual of this species.

Fig. 9 *a*, *b*. Interior of the ventral valve.

Fig. 10 *a*, *b*, *c*. Interior of the dorsal valve.

Fig. 10 *d*. Profile showing the comparative elevation of the cardinal and brachial processes.

Fig. 11 *a*, *b*. Casts of the ventral valve.

Fig. 12 *a*, *b*. Casts of the dorsal valve.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains; Catskill, Hudson, Schoharie, etc.

Orthis concinna (n. s.).

PLATE XIII. FIG. 1 – 3.

Compare *Orthis parva*, PANDER, Vern. M. V. K. Geol. Russ. pa. 188, pl. 13, f. 3.

SHELL longitudinally semielliptical : valves unequally convex : hinge line straight, with the extremities subangular. Dorsal valve convex, with a depression from beak to base, on each side of which the shell is more convex, and thence sloping somewhat abruptly to the sides : beak very small, and scarcely incurved. Ventral valve very convex, gibbous, and almost subcarinate in the middle : beak prominent, much elevated above the hinge line, and neatly incurved over the area. Area comparatively large, the length greater than half the width of the shell.

SURFACE very finely and evenly striated.

This species bears some resemblance to *O. elegantula* of the Niagara group; but it is more finely and beautifully striated, the dorsal valve is more gibbous, and distinctly marked by a rounded depression down the centre; the hinge line is more extended; the area is higher; the ventral valve is more gibbous, and the beak less arched.

In some points, the form of this species resembles *O. parva*, a Lower Silurian species; but the dorsal valve is usually more gibbous, while the striæ are finer, more equal, and less disposed in fascicles.

Fig. 1 *a*, *b*, *c*, *d*. Ventral, dorsal, profile, and cardinal views of a small specimen.

Fig. 2 *a*. A larger individual.

Fig. 2 *b*. Enlargement of the area and foramen.

Fig. 3. Enlargement of striæ.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Cumberland, Maryland.

Orthis insignis (n. s.).

PLATE XIII. FIG. 13 – 15.

SHELL pyramidal, minute. Dorsal valve semicircular, nearly flat, with a well-marked sinus down the middle. Ventral valve extremely elevated, pointed, straight or incurved. Hinge line greater than the width of the shell. Area large, extending to the salient hinge extremities : foramen large.

SURFACE coarsely striated : striæ rarely bifurcating.

This shell bears some resemblance to *O. pyramidalis* of the Niagara group; but it is more angular in form, the dorsal valve is conspicuously depressed in the centre, and the beak of the ventral valve is more produced.

Fig. 13. Dorsal view, natural size.

Fig. 14 & 15. Dorsal valve and area magnified.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains.

Orthis peduncularis (n. s.).

PLATE XIII. FIG. 16 *a* – *c*.

SHELL subplanoconvex? Ventral valve with the area about one-third as high as wide, the width equal to half the width of the shell : beak slightly incurved : teeth strong : muscular impressions very deep and strong.

SURFACE finely striated.

I have but a fragment of this species, which, in its general aspect, bears much analogy to *O. perelegans* and *O. subcarinata* ; but the area is proportionally much higher, and the beak less incurved than in either of those, while the muscular imprints are much larger and stronger. Other specimens are required for a complete comparison and description.

Fig. 16 *a*. Exterior of an imperfect ventral valve.

Fig. 16 *b*. Interior of the same.

Fig. 16 *c*. View of the area.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mouniains.

Orthis deformis (n. s.).

PLATE XV. FIG. 3 ; and PLATE X A. FIG. 13, 14.

SHELL suborbicular, lenticular. Ventral valve more convex than the opposite, most elevated between the centre and beak : beak straight, or often distorted in consequence of having been the point by which the shell was attached. Dorsal valve depressed convex, most elevated near the beak : beak not extending beyond the hinge line. Hinge line straight, equalling about three-fourths the width of the shell. Area broad, flat, sometimes nearly on a plane with the axis of the shell. Foramen closed above, and filled below by the strong cardinal process.

SURFACE marked by prominent rounded striæ, which increase by implantation, and are crossed at intervals by distinct subimbricating concentric lines of growth.

The striæ are distinctly tubular, with openings at the more conspicuous lines of growth. The fine concentric striæ are often scarcely visible in the silicified specimens.

This shell has much the general habit of a Carboniferous species usually referred to *O. umbraculum*; but it is not resupinate, and differs materially in other characters. The specimen figured on Plate xv is much distorted, perhaps in part by accident. A more symmetrical form is figured on Plate x A.

I have thus far seen no young of this species; and among very extensive collections continued in the Helderberg for more than ten years, only two or three specimens have been found, and these appear to be of full-grown individuals.

Fig. 3 *a*. View of dorsal valve and area of the ventral valve.

Fig. 3 *b*. Ventral valve of the same specimen, showing the contracted and distorted beak.

PLATE X A.

Fig. 13 *a*. Dorsal view, showing the extent of area, the broken beak, etc.

Fig. 13 *b*. Ventral valve of the same, showing the abrupt contraction of the striæ towards the beak, which is broken off below the point of attachment.

Fig. 14. Enlargement of striæ, showing the tubular openings at the imbricating lines of growth.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains.

Orthis assimilis (n. s.).

PLATE XV. FIG. 1 *a* – *e*.

SHELL suborbicular, sometimes a little longer than wide : valves nearly equally convex above the middle. Dorsal valve most convex in the middle, and sloping to the front and sides. Ventral valve most convex towards the beak, depressed and broadly sinuate below : beak prominent, acute, incurved, and extending beyond the opposite valve. Area longer than half the width of the shell; the height equal to one-third the length. Foramen large.

SURFACE finely and somewhat evenly striated. Vascular impressions of the ventral valve foliate, occupying a broad ovate space, limited on the sides by a continuation of the brachial lamellæ.

This species has a general resemblance to *O. oblata*, but is more nearly circular, and sometimes longer than wide. The ventral valve is conspicuously sinuate in the middle, and curves downwards to the margin, instead of spreading laterally with a general concave surface. The area is larger and proportionally higher.

Fig. 1 *a*, *b*, *c*, *d*. Ventral, dorsal, profile, and front views of a small specimen.

Fig. 1 *e*. Cast of the ventral valve of a larger individual, showing the vascular and muscular impressions.

Geological position and locality. In the Upper Pentamerus limestone of the Lower Helderberg group : Helderberg mountains; Schoharie.

Orthis multistriata (n. s.).

PLATE XV. FIG. 2 *a* – *t*.

SHELL circular or transversely suboval. Ventral valve most convex near the beak, depressed below so as to form a broad shallow undefined sinus, which sometimes gives to the front a subemarginate aspect: beak more prominent than the opposite, slightly incurved. Dorsal valve more elevated, gibbous between the middle and the beak : beak rising above the hinge, obtuse and incurved. Hinge line straight, about half the width of the shell. Area small, high. Foramen narrow, extending nearly to the apex.

SURFACE marked by fine, crowded, nearly equal striæ, which increase chiefly by implantation, and are crossed by a few faint concentric lines of growth.

Casts of the interior of the dorsal valve show very strong bilobed muscular impressions, which are broad and strongly striated below, and narrowed above. From the base of the muscular imprints radiate strong vascular impressions, which, in numerous finer ramifications, reach the base of the shell.

The cast of the ventral valve shows a deeply lobed subtriangular imprint of the muscular impressions, with rarely some remains of the vascular impressions extending downward into the broad sinus, which is even more strongly marked in the cast than in the shell itself.

This species is closely related to *Orthis tulliensis* of the Hamilton group, and is also a representative of the European Devonian and Carboniferous *O. resupinata*, particularly the more ventricose varieties of that species. So many distinct speci

however, are referred to that name, that the true *O. resupinata* seems scarcely to be known.

Our specimens are more gibbous and more finely striated than the form referred to *O. resupinata* by BARRANDE. The smaller forms figured by DE VERNEUIL (M. V. K. Geol. Russia, Pl. xii, f. 5) bear a very near resemblance to our fossil, while the larger forms have a larger area and more elevated beak : the cast of the ventral valve is likewise quite specifically distinct from ours. The smaller forms of the latter author are still more widely separated from the species under consideration. There is likewise a closely allied, if not identical form, in the limestones of the Upper Helderberg group.

The casts of *O. tulliensis* differ from the present species more conspicuously in the parallel direction of the vascular impressions below the muscular imprints of the dorsal valve.

Fig. 2 *a*, *b*, *c*. Dorsal, ventral and profile views of a very symmetrical specimen of medium size.

Fig. 2 *d*, *e*. Front and profile views of a larger individual.

Fig. 2 *f*. Cardinal view.

Fig. 2 *g*, *h*, *i*. Dorsal, ventral, and profile views of a large individual.

Fig. 2 *k*. Cast of ventral valve.

Fig. 2 *l*. Cast of dorsal valve of specimen 2 *k*.

Fig. *m*, *n*. Front and profile view of the preceding specimen.

Fig. 2 *o*, *p*. Casts of dorsal valves, showing muscular and vascular impressions.

Fig. 2 *r*. Cast of ventral valve of a full-grown individual.

Fig. 2 *s*, *t*. Front and profile view of the preceding.

Geological position and locality. In the Upper Pentamerus limestone of the Lower Helderberg group : Helderberg mountains; Schoharie, Catskill, etc.

Orthis strophomenoides (n. s.).

PLATE XIV. FIG. 2 *a* – *l*.

SHELL transverse, somewhat semioval. Ventral valve flattened convex, with a distinct narrow mesial elevation passing from beak to base : beak scarcely elevated above the hinge line, straight. Dorsal valve more convex than the opposite, most elevated between the middle and the beak, from which a distinct narrow depression gradually expands towards the front : beak more prominent than the opposite, obtuse,

scarcely incurved. Hinge line straight, nearly equalling the greatest width of the shell. Area linear, plane. Foramen apparently closed.

Surface marked by coarse radiating striæ, which frequently bifurcate and increase by implantation : several of those on the mesial elevation of the ventral valve appear to coalesce along the centre, before reaching the beak. In well-preserved specimens, strong concentric striæ are visible in the depressions between the radiating striæ. Shell marked by a few strong concentric undulations of growth.

The casts of the interior show the cavities made by the diverging teeth and the strong muscular imprints of the cavity beneath the beak, which, when well preserved, is cancellated by radiating and concentric lines. Vascular impressions radiating and ramifying from the muscular cavity, and diverging over the entire surface of the cast. Dorsal valve showing the cavities of the small cardinal process and the brachial lamellæ, the double imprints of the adductor muscles, and the ramifying vascular impressions.

This species is closely related to the *O. fasciata* of the Niagara group; but it is a larger shell, less angular at the extremities, and more deeply impressed along the centre of the valve.

This species may be compared with *O. desiderata* and *O. macrostoma* of Barrande, which are apparently opposite valves of a similar but smaller species.

This shell, in many of its features, holds an intermediate position to *Orthis* and *Strophomena* as defined by Davidson.

Fig. 2 *a*, *b*, *c*. The ventral valves of several specimens which are more or less exfoliated, so that the surface characters are not fully preserved.

Fig. 2 *d*, *e*. Casts of the ventral valve, showing the muscular and vascular impressions.

Fig. 2 *f*. Profile of a dorsal valve from which the shell is partially exfoliated.

Fig. 2 *g*, *h*. Two specimens of the dorsal valve, showing muscular and vascular impressions.

Fig. 2 *i*. Enlargement of the muscular and vascular impressions, cavities of cardinal and brachial processes, etc. of part of a dorsal valve.

Fig. 2 *k*. A farther enlargement of one side of the cast of a dorsal valve.

Fig. 2 *l*. Enlargement of the striæ, showing in the depressions some fine concentric striæ.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains and Hudson.

Orthis varica.

PLATE XXIV. FIG. 1 *a* – *k*.

Delthyris bilobata : CONRAD, Ann. Report on the Palæontology of New-York, 1838, p. 118.
D. *varica* : ID. Jour. Acad. Nat. Sciences, Vol. viii, 1842, pa. 262, pl. 14, f. 20.

SHELL subcordiform ventricose, deeply bilobed at the base, with a deep sulcus upon each valve reaching to the beaks : hinge line short. Area common to both valves; that of the ventral valve higher. Foramen high and narrow. Ventral valve arcuate, ventricose on each side of the sinus. Dorsal valve gibbous on each side the mesial sinus; each lobe becoming angular towards the beak, and compressed toward the cardinal extremities.

SURFACE unequally striated; a few distant striæ being visible to the naked eye, while under a lens the interspaces are seen to be distinctly striated. Fine concentric striæ cross the radiating striæ, and become conspicuous towards the base of the shell.

This species resembles the *O. biloba* of the Niagara group; but is a larger and more ventricose shell, with the dorsal valve conspicuously more gibbous, and the hinge line proportionally shorter.

Fig. 1 *a* – *g*. Figures showing the gradation of size, form, etc
Fig. 1 *k*. Enlargement of the radiating striæ.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains; Schoharie, Catskill, etc.

This species is rare in all the localities except at the base of the Helderberg near Clarksville, where more than 40,000 individuals were collected in the space of half a mile square, during a period of ten years.

Strophodonta varistriata.

PLATE VIII. FIG. 1 – 16; and PLATE XVI. FIG. 1 – 8.

Strophomena varistriata : CONRAD, Jour. Acad. Nat. Sci. Philadelphia, Vol. iii, pa. 255, pl. 14, f. 6.
S. rectilateris : Loc. citata, pa. 255, pl. 14, f. 7.
S. impressa : Loc. citata, pa. 255.
Leptæna indenta [?] : CONRAD, Ann. Rep. on the Palæontology of New-York, 1838, p. 117.

SHELL semioval, varying in form from length and width equal, to length greater or less than the width : hinge line equal to or greater than the width of the shell below; extremities rounded or salient. Dorsal valve flat, or more or less concave according to the convexity of the ventral valve, but not conforming entirely to the curvature of the latter. Ventral valve varying from slightly convex to gibbous, and sometimes abruptly arching towards the front : umbonial region more or less prominent; beak usually a little elevated. Area narrow, almost linear. Foramen linear or none*.

SURFACE often finely and evenly marked with straight or slightly undulating striæ; more often with prominent sharp striæ at more or less equal distances from each other, and the intermediate spaces by minute equal striæ; and again in other specimens by alternating larger and smaller striæ, of which there are frequently three regular gradations in size. Radiating striæ crossed by fine concentric elevated lines, and often by undulations or indentations which are more conspicuous on those shells where the striæ are in fascicles of finer between stronger ones. Vascular impressions of the ventral valve circumscribed by lamellæ, more or less distinctly flabellate : impressions of adductor muscles elongate-oval.

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* The representations of the foramen on Plate VIII are erroneous, there being no triangular opening of the kind; this feature proving, on careful examination in numerous individuals, to be due to fracture, as is common in this part of other species of the genus, and particularly in the separated valves of the typical species.

The great variety of surface marking, as well as of form and degree of convexity, has caused this shell to be referred to several distinct species. After a careful comparison of the specimens from the localities cited by Mr. CONRAD, and a large collection from other places, I am quite unable to discriminate specific distinctions. Indeed so gradual and almost imperceptible is the change from the greatest extremes, that no external characters can be seized upon for description, which are not liable to variation in the next specimen examined.

The descriptions given by Mr. CONRAD are as follows :

"*S. varistriata* (Pl. 14, f. 6). Semiorbicular : lower valve ventricose, slightly bent or suddenly rounded toward the base, with prominent sharp radii alternated in size, and the intervening spaces with minute longitudinal lines; umbo narrowed and convex; sides towards the hinge flattened; apex slightly prominent."

"*S. rectilateris* (Pl. 14, f. 7). Semioval : lower valve ventricose, with sharp crowded fine radii alternated in size; disk, from beak to base, regularly arched or convex; hinge extremities very little salient, angular; lateral margins obliquely subrectilinear; apex prominent."

"*S. impressa.* Semiorbicular or semioval : inferior valve ventricose or acutely rounded in the middle ; umbo convex depressed; apex on a line with the hinge margin; radii fine, crowded, unequal, on the lower half becoming distinct impressed lines, with intermediate very minute raised radiating lines."

"*Leptæna indenta.* Shell with radiating striæ; intervening spaces waved or indented. Length one inch."

The surface characters of *S. varistriata* are represented in the figures 9 and 10 of Plate VIII, and in figures 1 – 3 of Plate XVI; while the surface characters of *S. rectilateris* are seen in figures 4, 7 and 8 of Plate VIII, and figures 4 *a* – *d* of Plate XVI. The characters of striæ ascribed to *S. impressa* are only observed when the shell is partially or entirely exfoliated, leaving the impression of the stronger single striæ, while the intermediate finer ones appear to be elevated, as seen in figures 5 *a* – *d* of Plate XVI. This appearance is deceptive, and due in part to the character of the stone, and the close incorporation of the shell with the matrix. Greater or less ventricosity of the ventral valve accompanies all these varieties of surface.

The *Leptæna indenta*, cited above, as far as can be ascertained, was founded upon an individual of this species where the concentric wrinkles or indentations are stronger than usual, and may be regarded as represented in figures 7 *a*, *b* of Plate XVI. This is the only species known to me in this geological position, which possesses the characters described by Mr. CONRAD.

The specimens figured on Plate VIII are all from the thinbedded Tentaculite limestone of Schoharie and the Helderberg mountains.

PLATE VIII.

Fig. 1 – 6. Ventral valves, where the striæ are nearly equal or alternating in size.

Fig. 7 & 8. Individuals presenting some variety in surface characters.

Fig. 9. A young shell with salient hinge extremities, and strongly elevated striæ separated by fascicles of finer striæ between.

Fig. 5 *a*. The upper figure with this number is an enlargement of the surface of fig. 9.

Fig. 10. An individual with surface characters similar to the last, having the hinge extremities rounded, and the hinge line a little shorter than the greatest width of the shell below.

Fig. 11. Interior of a ventral valve.

Fig. 11 *a* (by error 12 *a*) above last figure. An enlargement of the area and crenulations.

Fig. 12 & 12 *a*. Interior of ventral valve, and enlargement of area.

Fig. 14 & 16. Casts of the interior of the ventral valve, where the shell is but partially exfoliated.

Fig. 15 & 15 *a*. The interior of a ventral valve, and enlargement of a portion of the same. In this specimen the hinge line has been broken, and the flabellate vascular impressions almost obliterated in the process of cleaning the shell.

Fig. 16, at right hand of page. A portion of the surface much enlarged, showing the nearly equal striæ, crossed by finer concentric lines.

The specimens figured on Plate VIII are from the Tentaculite limestone and base of the Pentamerus limestone; and at the time they were engraved in 1849, were supposed to represent the species decribed by Mr. CONRAD as cited above.

PLATE XVI.

Fig. 1 *a*. A young individual slightly convex in the centre towards the beak, and flat at the sides.

Fig. 1 *b*. Profile showing the outline from beak to base.

Fig. 1 *c*. Enlargement showing the stronger elevated striæ with the finer intermediate ones, and the commencement of other stronger ones in the midst of the finer striæ.

Fig. 2. An individual of the same character, having a greater convexity near the beak.

Fig. 3 *a*. A similar form where the beak or umbo is not elevated, and the whole shell nearly flat.

Fig. 3 *b*. Profile showing the curvature of the shell near the base.

Fig. 3 *c*. Enlargement of striæ, showing the fasciculate character.

Fig. 3 *d*. A farther enlargement of the surface, showing the concentric striæ.

Fig. 4 *a*. An individual having the character of *S. rectilateris*.

Fig. 4 *b*. Profile of the same.

Fig. 4 *c*. Profile of an individual having similar characters of surface, with a greater convexity.

Fig. 4 *d*. Enlargement of striæ of 4 *a*, showing the alternating size and frequent bifurcation.

Fig. 5 *a*. The *S. impressa* of CONRAD, natural size.

Fig. 5 *b*. Profile of same, showing the abrupt bending or geniculation towards the base..

Fig. 5 *c*. Enlargement of striæ, showing the coarser ones with intermediate fascicles of smaller ones.

Fig. 5 *d*. A portion of the surface enlarged where partially exfoliated on an impression of the exterior surface, showing the impressed lines made by the stronger striæ; which is merely a reverse of fig. 5 *d*, or of fig. 3 *c* & 3 *d*.

Fig. 6. An individual with coarser striæ than usual, the surface partially exfoliated.

Fig. 6 *a*. The striæ enlarged, showing the punctate character of the surface.

Fig. 7 *a*, *b*. Illustrations of the surface of *Leptæna indenta*.

Fig. 8 *a*. Illustration of the hinge line, area, vascular impression, etc. of the ventral valve, showing the apparent foramen, which is due to fracture, and has not the regular triangular form of *Strophomena*.

Fig. 8 *b*. Enlargement of hinge line, teeth, etc. of the dorsal valve.

Geological position and locality. Extremely abundant in the Tentaculite limestone and Pentamerus limestone : Helderberg mountains; Hudson, Catskill, Schoharie, Carlisle, Jerusalem hill and Dryhill in Litchfield, Herkimer county, and at intermediate points.

In the Tentaculite limestone, this species presents great variety in its surface characters, size, form, and convexity. It bears much general resemblance to *Strophomena alternata* of the Trenton limestone; and the similarity of the latter rock, in its dark thin beds, makes the resemblance still stronger at first view. It occurs abundantly in the base of the Pentamerus limestone, but not unfrequently associated with *Strophodonta englypha*, *Rhynchonella semiplicata* and *Pentamerus galeatus*.

Strophodonta varistriata, var. arata.

PLATE XVIII. FIG. 1 *a* – *i*.

SHELL semielliptical, with the cardinal extremities more or less salient: hinge crenulate. Dorsal valve more or less concave. Ventral valve varying from moderately convex to very gibbous, and sometimes geniculate towards the front. Area narrow. Foramen none, or a narrow elevation or callosity in place of it.

SURFACE marked by very prominent sharp angular ridges and intermediate fine undulating striæ, which cover also the slopes of the ridges. Sometimes a few short wrinkles mark the spaces between the ridges, along the cardinal margin towards the hinge extremities.

This species was arranged and figured with others of the shaly limestone, in the belief of its being a very distinct species; but a careful comparison of a large number of specimens from the Tentaculite limestone of different localities, as well as from the Pentamerus limestone and shaly limestone, leaves so much doubt of any real difference among them, that I prefer, for the present, to refer this one to the same. The surface, whether with the shell or as a cast, shows the strong sharp ridges, the

sloping sides of which, and the intermediate spaces, are marked by beautifully undulating striæ having a different character from those usually seen in the Tentaculite limestone, but resembling those of fig. 1, Plate XVI, which is a very flat shell. The cast still preserves the marks of the striæ, which are punctate; and the interior shell is distinctly papillose along the lines of striæ.

The rock in which this form occurs is a brecciated semicrystalline limestone, which has retained the shells in a good degree of preservation; but the exterior surface usually adheres to the stone, leaving casts of the fossils.

The variations in form, convexity, and surface markings of this species, if we include all at present thus indicated, show very conclusively that such characters are not to be relied on in the discrimination of species, unless upon a comparison of a large number of specimens.

Fig. 1 *a*, *b*, *c*, *d*. Ventral valves of several specimens where the shell is more or less exfoliated, the last one being almost free from adhering shell.

Fig. 1 *e*, *f*, *g*. Profile views, showing the convexity of several individuals.

Fig. 1 *h*. The surface showing the ridges and striæ.

Fig. 1 *i*. A portion of a cast of the interior, which preserves the ridges, but shows no intermediate striæ.

Geological position and locality. In a crystalline band of the shaly limestone of the Lower Helderberg group : Becraft's mountain, Hudson.

Strophodonta planulata (n. s.).

PLATE XVI. FIG. 9 – 12.

SHELL semielliptical, width nearly one-half the length, plano-convex : hinge line greater than the width of the shell below; the cardinal extremities often salient. Dorsal valve flat. Ventral valve uniformly and very slightly convex, sometimes flattened towards the margins : beak scarcely elevated above the hinge line. Area linear. Foramen unknown.

SURFACE finely and evenly striated : striæ of the dorsal valve often flattened. Radiating striæ crossed by fine closely arranged concentric striæ, and sometimes with a few inconspicuous laminæ of growth, and towards the cardinal extremities by a few wrinkles or undulations.

This species, so far as known, presents but little variety in its external characters. All the specimens examined show a depressed convex ventral valve, while the dorsal valve is quite flat. The striæ are fine, equal or subequal, gently undulating, and increasing both by bifurcation and interstitial addition. A very slight exfoliation obliterates the concentric striæ. The surface, when very slightly weathered, presents numerous punctures arranged in lines parallel with the striæ; and these punctures are often visible upon the fresh unworn surface, somewhat like the openings in the striæ of several species of *Orthis*.

In the general form and flatness of its valves, this species resembles the *S. beckii;* but the striæ are much finer, the width proportionally greater, and the concentric wrinkles scarcely conspicuous. It is often associated with the preceding species, from which it is readily distinguished. It is more common, however, in the higher beds of the Pentamerus limestone.

Fig. 9 *a*. An individual of medium size, with the hinge extremities salient.

Fig. 9 *b*. Profile view of the same.

Fig. 9 *c*. Enlargement of the surface, showing the character of the radiating and concentric striæ.

Fig. 10. An individual showing some faint concentric undulations.

Fig. 11 *a*. A large individual nearly entire, having the exterior surface slightly weathered, and showing the punctæ along the striæ.

Fig. 11 *b*. Profile of the preceding specimen.

Fig. 11 *c*. Enlargement of the surface, showing the character of the striæ and arrangement of the punctæ.

Fig. 12. An individual in which the shell is partially removed, showing obscurely the form of the vascular impressions.

Geological position and locality. In the Pentamerus limestone of the Lower Helderberg group : Helderberg mountains; Schoharie, and Dryhill, town of Litchfield, Herkimer county.

Strophodonta headleyana (n. s.).

PLATE XX. FIG. 1, 2 & 3.

SHELL nearly semicircular, about three-fourths as long as broad. Ventral valve very concave especially near the front, sometimes depressed convex at the beak : beak scarcely elevated above the margins of the area. Dorsal valve depressed at the umbo, and very convex towards the front : beak not extending beyond the cardinal margin. Hinge line equalling the greatest width of the shell, crenulated. Area somewhat

wide, and marked by transverse striæ produced by the continuation of the crenulations from the hinge line across its surface. Foramen narrow, closed.

Surface marked by coarse sharply elevated striæ, which increase chiefly by implantation, and present a peculiar irregularly waved appearance.

This species bears much resemblance to *S. cavumbona;* but the striæ are unlike, the area is wider, and the form of the callosity closing the foramen is quite different. The specimens in my possession, though mature forms and larger than *S. punctulifera*, are never as abruptly curved as that species. The radiating striæ are crossed by fine concentric lines which are visible in the spaces between, while the casts of the striæ are often crenulate. The interiors of several ventral valves show some variety in the form of the muscular impressions, though they all present the essential features of double broad lobes with plicate or foliate impressions.

Fig. 1 *a*. Interior of the ventral valve, where the surface is marked by strong rounded striæ, and the muscular area striate. The hinge along its line of junction with the opposite valve presents a linear groove from the termination of the crenulations to the cardinal extremities : crenulations extending little more than one-third the length of the hinge line on either side of the centre.

Fig. 1 *b*. Enlargement of a portion of the hinge line and area of fig. 1 *a*.

Fig. 2 *a*, *b*. Interior of the ventral valve of two specimens which present some variation in the form of the muscular impressions.

Fig. 2 *c*. Enlargement of the papillose interior surface.

Fig. 2 *e*. Enlargement of the cast of the muscular area.

Fig. 2 *d*. Cast of a ventral valve, showing the narrow callosity which fills the foramen.

Fig. 2 *f*. Enlargement of the punctate casts of striæ.

Fig. 3 *a*. Exterior of a ventral valve, showing the peculiar interrupted striation.

Fig. 3 *b*. Profile showing the concavity of the ventral valve.

Fig. 3 *c*. Enlargement of a portion of the striæ.

Fig. 3 *d*. Interior of a valve having similar characters to fig. 3 *a*, but more deeply concave.

Fig. 3 *e*. Profile of fig. 2 *b*, showing the convexity of the interior of the valve.

Geological position and locality. In compact layers of the shaly limestone of the Lower Helderberg group : Helderberg mountains; Schoharie, Hudson, etc.

Strophodonta cavumbona (n. s.).

PLATE XXI. FIG. 1 – 3.

SHELL subsemicircular, from two- to four-fifths as long as wide, usually contracted below the extremities of the hinge line. Cardinal border sloping a little from the beaks, nearly or quite equalling the greatest width of the shell. Dorsal valve concave in the umbonial region and near the hinge, very convex in the middle and towards the front. Ventral valve flat or concave : beak very small, scarcely elevated above the cardinal margin. Hinge line straight, crenulated. Area linear, partly common to both valves, transversely striate on the ventral valve. Foramen small, narrow, closed by a callosity.

SURFACE marked by coarse irregular radiating striæ, which increase by implantation : concentric striæ very fine and closely arranged.

This species has the form of *S. punctulifera*, and possesses also many of the external characters. The best preserved specimen shows no puncta upon the exterior, and the striæ do not bifurcate as in characteristic specimens of that species. The surface of older specimens is marked by strong, elevated, angular striæ; often with comparatively broad, intermediate, nearly flat spaces which are marked by fine and almost imperceptible concentric striæ, and at intervals by the commencement of other stronger radiating striæ, which gradually become more and more numerous as well as more subdued towards the margin; so that the surface of this part often presents the appearance of being evenly striated.

The striæ are not always acutely angular, but rounded upon the upper and middle portions of the shell, with spaces between scarcely exceeding the striæ, and numerously bifurcated below as in fig. 1 *f*, Plate XXI. In other specimens, and particularly the young, the striæ are prominently angular, with the spaces equal to the striæ.

In young specimens the shell is nearly flat, or slightly curved towards the margin: as it grows older, it becomes more convex on the dorsal and more concave on the ventral valve, the surface characters meanwhile assuming various modifications.

Fig. 1 *a*, *c*. Ventral and dorsal valves of young specimens.
Fig. 1 *b*, *d*. The striæ in profile, and the surface enlarged.
Fig. 1 *e*. A partial cast of the ventral valve.
Fig. 1 *f*. The dorsal valve partially exfoliated, and showing the crenulations along the hinge line : the striæ are rounded and frequently bifurcating.

Fig. 1 *g*. The punctate surface shown where the shell is exfoliated.
Fig. 2. The dorsal valve of a well-preserved specimen.
Fig. 2 *c*. Profile of striæ, showing the elevations and flat surfaces between them.
Fig. 3. A ventral valve, probably of this species.

The specimen, Plate XVIII, fig. 3 *a*, presents characters which are somewhat intermediate to this one and *S. punctulifera;* the surface, when partially exfoliated, showing the punctate character represented in fig. 3 *h* of same plate.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains; Schoharie, Hudson, Catskill, etc.

Strophodonta punctulifera.

PLATE XXI. FIG. 4; and PLATE XXIII. FIG. 4 – 7.

Strophomena punctulifera : CONRAD, Ann. Report on the Palæontology of New-York, 1838, p. 117.
— — VANUXEM, Geol. Report Third District of New-York, 1843, pa. 122, fig.
S. englypha : CONRAD, Ann. Report Palæontology of New-York, 1841, p. 36.

SHELL subsemicircular, about four-fifths as long as wide. Ventral valve concave : beak not projecting beyond the hinge. Dorsal valve concave near the umbo, very convex near the middle : beak not elevated above the cardinal margin; sides somewhat contracted below the extremities of the hinge. Hinge line straight, nearly or quite equalling the greatest width of the shell, finely crenulated. Area narrow, linear, vertically striated. Foramen nearly closed, with a narrow prominent callosity along the centre.

SURFACE marked by strong sharp striæ, which increase by bifurcation and interstitial addition, becoming rapidly more numerous and finer towards the margins, and are distinctly punctate in the best preserved specimens.

The *Strophomena punctulifera* is described by Mr. CONRAD as "Shell with the "upper valve deeply concave : radiating striæ very numerous, prominent, angu- "lated, each with a series of very regular small elevated punctæ. Length two "inches. *Locality*, Helderberg mountains."

The specimen, fig. 4, Plate XXI, was regarded by Mr. VANUXEM as this species; and it appears to be identical with a strongly striated one in the Pentamerus limestone, which I have placed under the same designation. The striæ, even in those scarcely exfoliated, are marked by one or two rows of elevated pustules, which are

punctate at their extremities, and appear to be the bases of small tubular spines. This character, however, is very variable, and in some specimens obscure upon the surface of the shell, while it becomes conspicuous on the exfoliate specimens, and the casts are strongly punctate, while the interior of the shell is distinctly pustulose.

This species has the form of *S. englypha* of the European rocks, and has been considered as identical with that species. I find, also, that Mr. CONRAD, in his catalogue of species in Report of 1841, has omitted *S. punctulifera* and cited *S. englypha*.

Specimens of *S. englypha* from Gothland, with a very similar form, have strong angular striæ, between which are fascicles of three, four, five, or six smaller ones; a character not observed in the New-York specimens. The punctæ are finer in the European specimens than in ours, and the general aspect of the shell less rude. Our specimens are, for the most part, in such a condition as to afford very unsatisfactory material for illustration.

PLATE XXI.

Fig. 4 *a*. A cast of this species.

PLATE XXIII.

Fig. 4 *a*, *b*. The interior and profile view of the dorsal valve.

Fig. 5 *c*. Cardinal view, showing the area enlarged.

Fig. 6 *d*. Enlargement of part of the dorsal valve, showing the punctate surface, muscular and vascular impressions.

Fig. 7 *e*. Enlargement of striæ which are scarcely exfoliated, showing pustulose points, some of which are punctate at their extremities.

Geological position and locality. In the Pentamerus limestone and shaly limestone of the Lower Helderberg group : Helderberg mountains; Schoharie, Carlisle, Hudson, Catskill; Columbia, Herkimer county, etc.

Strophodonta leavenworthana (n. s.).

PLATE XXI. FIG. 5 – 7; and PLATE XXIII. FIG. 1 – 3.

SHELL semielliptical, about three-fourths as long as wide, contracted below the extremities of the hinge : cardinal border slightly sloping from the beak. Ventral valve convex at the umbo, flattened in the middle and on the cardinal margins, so as to form a semicircular inclined plane ascending from the hinge to beyond the middle of the shell; the front and lateral margins abruptly inflected, giving a deep concavity to the whole valve. Dorsal valve flattened or slightly concave in the umbonial and central regions, very convex and abruptly bent towards the front

and lateral margins. Hinge line equal to the greatest width of the shell, crenulated. Area linear, vertically striated. Foramen small, triangular, closed in full-grown individuals.

SURFACE marked by fine obscure closely arranged radiating striæ, crossed on the depressed part of the valves by small regular concentric wrinkles.

The interior of the ventral valve shows a narrow almost linear area, the inner margin of which is crenulated, the crenulations extending on each side more than half way from the centre to the cardinal extremities. In old shells there is no evidence of foramen, but a slight depression in the inner edge of the area (which may be accidental), with the two cavities beneath for the reception of the processes of the opposite valve. The vascular area is somewhat broadly ovate or cordate, with a prominent imprint of the adductor muscles, from which extends a narrow ridge through the centre of the muscular area. Another individual, apparently identical with this one, shows the muscular area more distinctly divided through the centre. An impression of the interior of the dorsal valve shows the strong imprints of adductor muscles, with cavities made by the teeth or cardinal processes.

This shell bears a general resemblance to *Strophomena depressa*. It differs, however, remarkably from that species in its resupinate character, the convexity and concavity of the valves being in the opposite direction : the area of the ventral valve is also wider, and the cardinal margin is crenulated.

PLATE XXI.

Fig. 5 *a*. The dorsal valve, showing obscurely the concentric wrinkles and the punctate surface where the shell is exfoliated.

Fig. 6 *a*. Interior of the ventral valve.

Fig. 6 *b*. Profile of the preceding.

Fig. 6 *c*. Enlargement of the crenulations of the hinge line of 6 *a*.

Fig. 7 *a*. Interior of a ventral valve.

Fig. 7 *b*. Profile of the same.

PLATE XXIII.

Fig. 1 *a*, *b*, *c*. Ventral, dorsal and profile views of an entire specimen.

Fig. 2 *a*, *b*, *c*. Dorsal and profile views of a full-grown individual.

Fig. 2 *e*. Enlargement of the fine equal striæ.

Fig. 3. Impression or cast of the interior of the dorsal valve.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains.

Strophodonta beckii (n. s.).

PLATE XXII. FIG. 1 *a* – *t*.

SHELL semielleptical or subquadrate : length sometimes equal to the width (though usually from two-thirds to three-fourths as great). Ventral valve very depressed convex : beak very small. Dorsal valve flat or a little concave near the hinge, slightly convex near the front. Hinge line crenulated, generally equal to the greatest width of the shell, but sometimes less. Area linear, confined to the ventral valve. Foramen small, linear, usually closed.

SURFACE marked with strong, regular, closely arranged, bifurcating, radiating striæ, crossed by fine obscure concentric lines, and more or less regular concentric wrinkles which curve outwards on approaching the hinge.

Interior of shells striato-punctate, the hinge line crenulated almost to its extremities. The muscular area of the ventral valve flabelliform, more or less strongly defined at its margins.

This is one of the most beautiful as well as most remarkable species of this genus in the rocks of the Helderberg group. Although corrugated like *Strophomena rugosa*, it is unlike that shell, in being almost entirely flat, and without the geniculation of that species.

In its young state, this shell is marked by regular, round, bifurcating striæ; the concentric wrinkles being scarcely developed. As the shell grows older these undulations become strong corrugations, which at first distinctly mark the upper part of the shell, and finally cover the entire surface. (In the figures 1 *d* – *e*, these corrugations are not sufficiently strong, but the character is fully shown in fig. 1 *i*.)

This species is very closely allied to *Strophomena* (*Leptæna*) *sowerbyi* of BARRANDE (Sil. Brach. aus Bœhmen, Pl. 21, f. 1 & 2 *a*, *b*, *c*, *e*); but differs from those figures in being more coarsely striate, with the concentric wrinkles stronger, especially near the beak : they are, also, generally more curved outwards near the hinge. The lateral margins of our shell are likewise, in most specimens, more contracted below the extremities of the hinge, than in the examples given by BARRANDE.

Fig. 1 *a*. A young individual in which no corrugations are developed.

Fig. 1 *b*, *c*. Two specimens exhibiting the extremes of form in the extension of the hinge line, and showing the beginning of the development of the corrugations.

Fig. 1 *d*. A specimen showing the corrugations more strongly.

Fig. 1 *e*. An individual of full size in which the corrugations are well developed.

Fig. 1 *f*, *g*. Dorsal and ventral sides of an entire individual.

Fig. 1 *h*. Profile view of the preceding specimen.

Fig. 1 *i*. An old specimen where the corrugations are much stronger and closer than usual.

Fig. 1 *k*, *l*, *m*. The interiors of several ventral valves, showing the area, crenulated hinge line, muscular and vascular impressions, etc.

Fig. 1 *n*. Area of the ventral valve.

Fig. 1 *r*. A portion of the area enlarged, showing the striated surface and crenulated margin.

Fig. 1 *s*, *t*. Portions of the casts of the ventral valve of two different individuals, showing some slight difference in the character and strength of the impressions.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains; Schoharie, Carlisle, Catskill, Hudson, etc.

The following species have no crenulations on the hinge line, and have broad triangular foramina, more or less closed by a pseudodeltidium, leaving the form of the foramen distinctly visible.

Strophomena woolworthana (n. s.).

PLATE XVII. FIG. 1 & 2.

SHELL semielliptical, often extremely elongate. Ventral valve concave towards the front and flat on the lateral margins, depressed convex near the beak : beak small, and scarcely rising above the edge of the valve. Dorsal valve convex, most elevated near the front, and flattened towards the umbo : beak not projecting. Hinge line straight, equal to the greatest width of the shell. Area linear, conspicuous, partly common to both valves. Foramen broadly triangular, partially or entirely closed.

SURFACE finely striated. Striæ round, crowded, simple, increasing by interstitial addition, concentrically crossed by closely arranged striæ and a few distant lines of growth.

Ventral valve marked interiorly by a broad flabellate vascular area, which is partially limited by the dental lamellæ : teeth strong, projecting more or less into the interior of the valve; in old shells, less conspicuous. Dorsal valve with vascular area strongly marked : cardinal process deeply bifid, and each division again trilobate upon the exterior side; lateral lamellæ curving as in *Orthis*.

This species is one of a small group including *S. pecten* and *S. subplana*, which possess characters assimilating them with *Orthis*. In the present example, the strongly marked vascular impressions, and the bifid and lobed cardinal process filling the lower part of the foramen, are characteristic of *Orthis*, while the closed foramen and linear area are characters of *Strophomena*.

Fig. 1 *a*. Ventral valve of an individual of medium size.

Fig. 1 *b*. Dorsal valve of a larger individual, showing the area of the opposite valve and the closed foramen.

Fig. 1 *c*. Ventral valve of the same.

Fig. 1 *d*. Profile view of the same.

Fig. 1 *e*. Ventral valve of a large individual.

Fig. 1 *f*. View of area of fig. 1 *e*.

Fig. 1 *g*. Cardinal view of an entire individual, showing the area of the ventral valve, and the convexity of the dorsal valve.

Fig. 1 *h*, *i*, *k*, *l*. Interior of the ventral valves of several individuals of different size, and showing some variety in form of the vascular impressions.

Fig. 1 *m*. A cast of the ventral valve.

Fig. 1 *n*, *o*. Interior of dorsal valves, showing the cardinal processes, with some difference in the strength of the muscular impressions and proportional length of the hinge line.

Fig. 1 *p*, *r*. Cardinal view of ventral valve, showing the cardinal process, and the same enlarged.

Fig. 2 *a*, *b*, *c*. Casts of the interior of the dorsal valves of several individuals.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains; Schoharie, Carlisle, Hudson and Catskill.

Strophomena radiata.

PLATE XXI. FIG. 8 & 9; and PLATE XVIII. FIG. 3 *b*, *c*, *d*, *e*.

Strophomena radiata : VANUXEM, Report Third District of New-York, pa. 122, f. 6.

SHELL nearly semicircular, about three-fourths as long as wide. Ventral valve flat or subconcave, except near the umbo, where it is depressed convex : beak rising a little above the line of the cardinal margin. Dorsal valve flat or slightly concave near the beak and towards the extremities, very gibbous in the middle and towards the front : beak not elevated above the cardinal margin. Hinge line equalling or greater than the greatest width of the shell, apparently not crenulated.

SURFACE marked by distinct radiating striæ, which increase by implanta-

tion and bifurcation, and are crossed by fine concentric striæ. Interior indistinctly granulose.

The original specimen from which Mr. VANUXEM described this species is the dorsal valve figured on Plate XXI, fig. 8 *a*. The shell is partially exfoliated, and the interior surface shows the fine concentric lines crossing the radiating striæ. Fig. 1 *a* is a similar specimen proportionally shorter, being almost semicircular in form. I have referred to the same species the figures 3 *b*, *c*, *d* and *e*, Plate XVIII, which are casts preserving the remains of the striæ in a good degree of perfection.

The great similarity in the surface markings, and the approximation in form of this species with *S. woolworthana*, suggest a doubt as to the propriety of separating the two as distinct species.

The name *Strophomena costellata* of CONRAD, in his catalogues in annual reports, was applied to this species.

PLATE XXI.

Fig. 8 *a*. A figure of the original specimen with the shell in part exfoliated.

Fig. 8 *b*. Enlargement of the radiating and concentric striæ.

Fig. 9 *a*. A smaller individual from the same locality.

Fig. 9 *b*. Enlargement of surface when the shell is partially exfoliated.

PLATE XVIII.

Fig. 3 *b*, *c*, *d*, *e*. Casts of the same species.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Columbia, Herkimer County; Hudson, etc.

Strophomena conradi.

PLATE XVI. FIG. 13 & 14.

SHELL semielliptical, varying from length and breadth equal, to breadth one-fourth greater than the length. Hinge line scarcely equalling the greatest width of the shell. Dorsal valve very convex, and somewhat gibbous in the middle, regularly sloping on all sides, and scarcely flattened at the hinge extremities. Area unknown.

SURFACE uniformly striated with fine sharp striæ, which are rounded by exfoliation.

This species is described from two individuals which present some variety of proportions, but which are essentially different from any other species known to me

in these rocks. The form is not unlike *S. woolworthana*, but it is much more convex, the greatest convexity being in the middle, while in that it is near the front. This one is not flattened near the umbo as is that species, and it differs moreover in the character of the striæ.

Fig. 13. The dorsal valve. Fig. 14. Profile view of the same.

Geological position and locality. In the Pentamerus limestone of the Lower Helderberg group : Schoharie.

Strophomena rugosa*.

PLATE XIX. FIG. 1 *a* – *y*.

Dritte Anomiten art mit breiter schlosskante: HUPSCH, Naturgeschichte des Neiderdeutschland, 1781, Vol. i, pa. 15, pl. 1, f. 7 & 8.

Anomites rhomboidalis : WAHLENBERG, Acta Soc. S. Upsaliensis, 1821, Vol. viii, pa. 65, n° 7.

Producta depressa : SOWERBY, Genera of Shells; and Min. Conchology, 1825, Vol. v, pa. 86, pl. 459, f. 3.

P. rugosa : HISINGER, Vet. Acad. Handlingar, 1826, p. 33.

Productus depressus : DEFRANC, Dict. des Sciences naturelles, 1826, Vol. xlvii, p. 353.

Leptæna rugosa : DALMAN, Vet. Acad. Handlingar, 1827, pa. 106, pl. 1, f. 1.

L. depressa : ID. Ib., pa. 107, pl. 1, f. 2.

Strophomena rugosa : BRONN, Leth. geognostica, 1827, Vol. i, pa. 87, pl. 2, f. 8.

Producta depressa : PHILLIPS, Geol. Yorkshire, 1846, Vol. ii, pa. 215, pl. 8, f. 18.

Productus depressus : DESHAYES, Lamarck Animaux sans vertebres, 2d edition, Vol. viii, p. 380.

Leptæna rugosa and *L. depressa* : HISINGER, Leth. Suecica, 1837, pa. 69, pl. 20, f. 2 & 3.

Orthis rugosa : VON BUCH, Ueber Delthyris, 1837, p. 30.

Leptæna : FISCHER, Oryct. du Gouvernement du Moscou, 1837, p. 143.

Leptæna depressa : J. SOWERBY, in Murchison Sil. System, 1839, pa. 623 & 636, pl. 12, f. 2.

L. tenuistriata [?] : ID. Ib., pa. 646, pl. 22, f. 2 a.

L. rugosa : ID., Trans. Geol. Soc. London, 1840, 2d series, Vol. v, pl. 56, f. 4.

Orthis rugosa : EICHWALD, Sil. System in Esthland, p. 162.

Leptæna rugosa : PHILLIPS, Pal. Fossils, 1841, pa. 57, pl. 24, f. 95.

L. depressa : DE KONINCK, Desc. An. Fossiles de Belgique, 1842, pa. 215, pl. 12, f. 3 – 6; and pl. 13, f. 6.

— — G. B. SOWERBY, Conch. Manual, 1842, pa. 71 & 300, f. 206.

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* *Strophomena rhomboidalis*: "Nommé *Conchites rhomboidalis*, *Anomia inequilateri*, par C. WILCKENS, Nachricht von seltener versteinerungen, pag. 79, tab. viii, f. 43, 1769. = *Leptæna depressa*, SOWERBY, which is also the *Anomites rhomboidalis* of WAHLENBERG, D'ORBIGNY, &c."— NOTE on page 137 of the French edition of DAVIDSON's Introduction to the Study of the Brachiopoda.

I leave the name *Strophomena rugosa* preceding the description of this species; believing this to be the typical species of RAFINESQUE's Genus STROPHOMENA, and as such it has always been recognized by American palæontologists, though we have no published description or figures for reference.

Among some shells and fossils purchased by Mr. POULSON of Philadelphia, from Professor RAFINESQUE's collections, there are specimens of this species, labelled, in the handwriting of the latter, *Strophomena rugosa*; leaving no doubt as to the true intention and application of this name by its author.

Orthis rugosa : D'Archiac et De Verneuil, Trans. Geol. Society London, 1842, 2d series, Vol. vi, part 2, p. 396.
Strophomena depressa : Vanuxem, Geol. Report Third District New-York, 1842, pa. 79, f. 5.
S. undulata : Id. Ib., pa. 139, f. 3.
S. depressa : Hall, Geol. Report Fourth District New-York, 1843, pa. 77, f. 5; and pa. 104, f. 2.
Orthis rugosa : F. C. Rœmer, Rhein. Uebergangsgebirge, 1844, pp. 85 & 90.
Leptæna depressa : De Verneuil, Geol. Russ. and the Ural, 1845, Vol. ii, pa. 234, pl. 15, f. 7.
— — Hall, Palæontology of New-York, 1847, Vol. ii, p. 257.
Strophomena rhomboidalis : Davidson, Intr. Nat. Hist. Brachiopoda.

Shell varying from semioval to semicircular. Hinge line equalling or greater than the width of the shell below : cardinal extremities often much extended. Dorsal valve flat or slightly concave in the upper part, and abruptly curving or inflated towards the front : beak prominent, perforate at its apex, and filling a deep sinus in the opposite valve. Ventral valve slightly convex or nearly flat in its upper part, and sometimes even concave; convex upon the umbo, often perforate near the beak; abruptly deflected or geniculate towards the front : cardinal area narrow, linear, partially occupying both valves. Foramen of the ventral valve a broad, shallow sinus, which is filled by the prominent cardinal process of the opposite valve, the latter being perforate or deeply grooved for the passage of a pedicle.

Surface marked by regular, rounded, radiating striæ, which increase by bifurcation and interstitial addition : the upper part of the valves marked by strong concentric wrinkles which do not extend below the abrupt bending of the valves.

The interior of the shell is striato-punctate, or sometimes simply punctate. The muscular areas of the ventral valve are strong, more or less deeply bilobed, and limited by the extension of the dental lamellæ. The interior of the dorsal valve is strongly marked by the muscular impressions; the dental process perforate near its outer surface, or deeply grooved; and there is often a deep cavity below this, extending towards the beak.

This shell exhibits much variety of form, being sometimes nearly flat or but slightly curved near the margin; and the corrugations are variable in number and strength. In very old shells they are often not as prominent as in younger ones, or those of medium size. The area, as usually exposed, is subject to much variation,

and not unfrequently the valves are so closed as to leave no visible area. The beak of the dorsal valve, either at or just within its extremity, shows a rounded perforation or groove; and the beak of the opposite valve is marked by a rounded, shallow groove, which, extending downwards, often ends in a perforation both in young and old shells. Sometimes the groove only is visible, the perforation having doubtless once existed, but subsequently closed. In some specimens there is a simple indentation on the beak.

Fig. 1 *a* – *i*. Figures illustrating the usual characters presented by the shells of this species.

Fig. 1 *k* (by error marked 1 *s*). Profile showing the great extent of the deflected portion of the shell. Between this one and 1 *b* +, there are every possible gradation.

Fig. 2 & 2 +. Specimens which are slightly curved, and showing a larger number of corrugations than usual, which extend nearly to the base of the shell.
These specimens are from the Upper Pentamerus limestone, and all those observed from this rock preserve a similar character.

Fig. 1 *l*, *m*, *n*. Interior of the dorsal valves, showing some variety of characters.

Fig. 1 *o*, *p*, *q*. Casts or moulds left in the stone by the dorsal valves of several individuals.

Fig. 1 *q* +. Enlargement of the muscular imprints, etc.

Fig. 1 *r*, *s*, *t*. Interior of several individuals of the ventral valve.

Fig. 1 *u*, *x*, *y*. Casts of the interior of the ventral valve fig. 1 *u*, still retaining a portion of the shell.

Geological position and locality. In the Pentamerus and shaly limestone of the Lower Helderberg group, but principally in the latter rock : Helderberg mountains, Schoharie, Carlisle, Catskill, Hudson, etc.

Leptæna concava (n. s.).

PLATE XVIII. FIG. 2.

SHELL concavo-convex, hemispherical. Ventral valve regularly convex : umbonial region prominent; cardinal margin rounding from the beak towards the lateral extremities. Dorsal valve deeply concave. Hinge line less than the greatest width of the shell. Area of ventral valve broad, that of dorsal valve linear. Foramen triangular, nearly closed above by a thick callosity, the lower part occupied by the prominent cardinal process of the opposite valve.

SURFACE marked by very fine close radiating striæ, each fifth or sixth one a little more prominent than those between; crossed by fine regular concentric wrinkles, producing a beautiful subcancellate appearance.

This species bears some analogy to the *L. transversalis* of the Niagara group, but is proportionally shorter on the hinge line, and the area is much higher; the intermediate striæ are coarser, and the concentric wrinkles are not observed in the species from the Niagara group.

Fig. 2 *a*, *b*. Ventral and dorsal views. Fig. 2 *c*. Profile view. Fig. 2. Enlargement of area, foramen, etc.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains, Albany county.

Spirifer vanuxemi.

PLATE VIII. FIG. 17 – 23.

Orthis plicata : VANUXEM, Geol. Report Third District New-York, 1843, pa. 112, f. 1.
Not *Spirifer plicatus* of SOWERBY, of HORN, or of STEININGER.

SHELL rhomboidal, moderately gibbous : extremities rounded. Ventral valve the less convex, having the beak elevated and incurved. Area small.

SURFACE marked by broad rounded or somewhat flattened and sometimes undefined plications, of which there are from two to four on each side of the mesial fold and sinus; concentrically marked by fine closely arranged undulating striæ and stronger imbricating lines of growth, which are again crossed by still finer radiating striæ; the latter visible only under a magnifier.

This species resembles very closely the *S. crispus* of the Niagara group; but all the specimens examined from the Lower Helderberg group have a smaller area and less elevated beak of the ventral valve, as well as a less gibbous form. The concentric striæ are more rounded and much more interrupted by inequalities of surface from laminæ of growth, while the fine longitudinal striæ are stronger and more continuous.

The *S. vanuxemi* is extremely abundant in certain parts of the Tentaculite limestone, and occurs in the base of the Pentamerus limestone. It differs from the *S. cyclopterus* of the shaly limestone in its smaller size and less numerous plications, as well as in the fine concentric and radiating striæ of the surface.

Fig. 17, 18 & 19. Young individuals of this species.

Fig. 20 – 23. Dorsal, ventral, profile, and front views of several individuals.

Geological position and locality. In the Tentaculite limestone of the Lower Helderberg group : Helderberg mountains, Albany county; Schoharie, Carlisle, Litchfield in Herkimer county, and other places.

Spirifer cyclopterus (n. s.).

PLATE XXV. FIG. 1 *a* – *z*.

SHELL semicircular : extremities of the hinge line more or less symmetrically rounded. Ventral valve gibbous : beak elevated, more or less incurved; sinus moderately deep, curved on the sides and nearly flat in the middle. Dorsal valve very convex towards the middle, the mesial fold abruptly elevated and very prominent : beak little elevated above the hinge line, and scarcely incurved. Area moderate, scarcely extending to the extremity of the hinge line. Foramen large.

SURFACE marked by five to seven rounded plications on each side of the mesial line, concentrically marked by fine close imbricating lamellose striæ, which are more or less prominent, depending on the condition of preservation in the shell : surface of lamellæ ornamented by short fine vertical striæ or crenulations, which project in fimbriæ on the edge of the lamellæ.

This species presents comparatively little variety in form; though there are, rarely, to be found individuals with the cardinal extremities much extended as in fig. 1 *g*, and others where the extremities are subangular as in fig. 1 *l*. The greater number, however, are rounded as in 1 *a* – *i*.

In its surface characters this species resembles *S. crispus* of the Niagara group, but is much larger, has a greater number of plications, and a narrower and longer area; while the valves are more nearly equal in size, and the beak of the ventral valve is more elevated. Where the specimens are small, the surface characters alone are sufficient to distinguish one from the other. The muscular impressions of the ventral valve are very deep and strong, the margins of the foramen terminating in prominent teeth.

This species likewise resembles *S. duodenaria* of the Upper Helderberg limestone; but the latter has a narrower area, a less prominent beak of the ventral valve, and a shallow sinus, while the mesial fold of the opposite valve is less prominent.

Fig. 1 *a–s*. Figures of several individuals showing gradations in size, modifications of form, etc.

Fig. 1 *u*. Enlargement of surface, where the edges of the lamellæ are ornamented with little granules, giving the appearance in profile as represented in fig. 1 *z*.

Fig. 1 *y*. The surface where the granules are worn off, and the lamellæ are seen to be finely striated.

Fig. 1 *z*. Profile of the imbricating concentric striæ.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains; Schoharie, Catskill, Hudson, etc.

Spirifer concinnus (n. s.).

PLATE XXV. FIG. 2 *a* – *i*; and PLATE XXVIII. FIG. 7.

SHELL semicircular or semielliptical : extremities rounded or salient; valves almost equally convex. Ventral valve gibbous towards the beak: beak more or less elevated above the hinge line, and abruptly incurved at the apex : mesial sinus subangular, and produced into an angular extension which is much elevated, and sometimes slightly incurved in front. Dorsal valve very convex in the centre : beak scarcely incurved; mesial elevation obtusely and sometimes acutely angular. Hinge line equal to or a little less than the width of the shell. Area of medium size, well defined, and extending to the extremities of the hinge line.

SURFACE marked by from twelve to fourteen rounded, little elevated, simple costæ on each side of the mesial lobe and sinus; concentrically marked by imbricating lamellæ, which are striated upon their surfaces and granular on the edges.

In many specimens there are faint indications of a fold on each side of the mesial sinus, and of several similar ones upon the corresponding mesial elevation : this character, however, is not constant in the specimens examined.

This species is subject to considerable variation in form, the length and breadth being sometimes nearly equal, and the cardinal extremities rounded, while in other specimens these are salient. I have seen two specimens only in the shaly limestone; the ordinary position of this species being in the Upper Pentamerus limestone, associated with *Pentamerus pseudogaleatus*, etc. The finer surface markings do not differ very essentially from *S. cyclopterus*, but the angular character of the sinus and mesial fold with obscure plications, the much more elevated beak of the ventral valve, and more numerous plications are distinguishing features.

PLATE XXV.

Fig. 2 *a* – *e*. Views of a single large specimen from the shaly limestone.

Fig. 2 *f*. Enlargement of the surface.

Fig. 2 *g*, *h*, *i*. Dorsal and front views of specimens from the Upper Pentamerus limestone.

PLATE XXVIII.

Fig. 7 *a*, *b*. Dorsal and ventral views of a larger specimen from the Upper Pentamerus limestone.

Geological position and locality. In the shaly limestone of the Lower Helderberg group; Helderberg mountains and Hudson, rarely : Upper Pentamerus limestone; Schoharie and Helderberg mountains.

Spirifer perlamellosus (n. s.).

PLATE XXVI. FIG. 1 & 2.

Spirifer rugosa : HALL in Catalogue.

SHELL trigonal or semicircular, more or less extended on the hinge line, the extremities varying from obtuse or rounded to extremely mucronate. Ventral valve arcuate, the beak much extended beyond the opposite valve, and incurved at the apex : sinus deep, gradually expanding, and produced in front into a linguiform extension. Dorsal valve convex towards the middle, the mesial elevation very prominent, and the beak closely incurved against the area, or partially closing the foramen of the ventral valve. Area moderately wide, frequently much expanded, and becoming linear towards the extremities when the shell is much extended.

SURFACE marked by four to six strong and abruptly elevated plications on each side of the mesial sinus and elevation, concentrically marked by strong imbricating lamellæ, which are abruptly arched in passing over the plications, giving an extreme roughness to the surface. In well-preserved specimens, finer longitudinal striæ mark the surface of these lamellæ. In ordinary specimens, the concentric lamellæ are more closely arranged and more distinctly imbricate towards the margin; while near the beaks they are more distant, and are scarcely imbricate.

This species, in its young state, closely resembles the *S. sulcatus* of the Niagara group; but this shell is more rugose, and the lamellæ less arched on the plications, which are also less numerous in specimens of the same size. The area, in both species, is subject to much variation.

The form of this species varies mainly in the greater or less extension of the cardinal extremities.

Fig. 1 *a* – *s*. Illustrations of gradations of size and differences of form presented by this species.
Fig. *t*. Enlargement of surface, showing the concentric lamellæ [which are not strong enough in the figure] and the fine longitudinal striæ.
Fig. 2 *a*, *b*. Interiors of ventral valves. Fig. 2 *c*, *d*, *e*. Interiors of dorsal valves.
Fig. 2 *f*, *g*. Cast of the interior, and enlargement of the papillose surface.

Geological position and locality. In the shaly limestone of the Lower Helderberg group, and rarely in the Pentamerus limestone : Helderberg mountains; Schoharie, Carlisle, Catskill, Hudson, Cherryvalley, etc.

Spirifer macropleurus.

PLATE XXVII. FIG. 1 *a* – *p*; and PLATE XXVIII. FIG. 8 *a* – *d*.

Delthyris macropleura : CONRAD, An. Report on Palæontology of New-York, 1840, p. 217.
— — VANUXEM, Rep. on Geology Third District New-York, 1843, pa. 120, f. 1.
— — MATHER, Rep. on Geology First District New-York, 1843, pa. 343, f. 1.

SHELL large, varying from semielliptical to semicircular or transversely elliptical, ventricose : valves nearly equally convex; hinge line often scarcely equalling the greatest width of the shell. Area narrow. Foramen large. Ventral valve with a broad deep curved sinus and three strong rounded plications on each side : beak moderately elevated above the opposite, and abruptly incurved. Dorsal valve with a broad rounded mesial fold and two strong rounded plications, with sometimes a third one on each side.

SURFACE marked by fine closely arranged radiating striæ, which are crossed by finer concentric ones (the latter rarely visible).

This species, in its general characters, is a representative of the type of a group of which *S. radiatus* and *S. niagarensis* are the earliest known forms; and is the only one of this character that I have seen in the Lower Helderberg group in New-York.

PLATE XXVII.

Fig. 1 *a*. A young shell in which the plications are but faintly developed.

Fig. 1 *b*, *c*. Dorsal and profile views of a specimen of medium size.

Fig. 1 *d* & *h*. Front and cardinal views of the same.

Fig. 1 *e*, *f*, *g*. Dorsal, front and cardinal views of a very symmetrical form of medium size.

Fig. 1 *k*. Ventral view of a larger individual.

Fig. 1 *l*. Cast which is somewhat crushed from the base.

Fig. 1 *m*, *n*. Interior of the ventral valve, and cast of the same.

Fig. 1 *o*. Part of the exterior of a slightly weathered specimen, showing the extremity of the spire.

Fig. 1 *p*. Enlargement of the radiating striæ as seen under a lens upon the surface of ordinary specimens.

PLATE XXVIII.

Fig. 8 *a*, *b*, *c*. Casts of the ventral valve showing some variety in the forms of the muscular impressions.

Fig. 8 *d*. Enlargement of the surface striæ, taken from a mould of the exterior in the shaly limestone, where the shell has decomposed.
[This character is rarely well preserved on the surface of the fossil.]

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains ; Schoharie, Carlisle, Catskill, Hudson ; Pennsylvania, Maryland and Tennessee.

Spirifer modestus (n. s.).

PLATE XXVIII. FIG. 1 *a* – *e*.

SHELL small, subglobose. Ventral valve very gibbous near the middle and towards the beak, having a shallow undefined sinus extending from the beak to the front : beak prominent, acutely pointed, incurved. Dorsal valve regularly convex, semicircular or subtriangular : extremities rounded, sometimes an undefined mesial elevation : beak scarcely extending above the hinge line, not incurved; hinge line very short, rounded at the cardinal extremities. Area triangular, faintly defined, about half the width of the shell, arcuate. Foramen of medium size, narrow, triangular. Dental lamellæ slightly diverging, and extending more than half way to the base of the shell.

SURFACE marked by faint concentric lines of growth.

This species resembles somewhat *Nucleospira ventricosa* of the Lower Helderberg shaly limestone, but has a much higher area : it still more resembles *S. lineatus* of the Carboniferous system, but differs in its surface markings and its narrower foramen.

Fig. 1 *a*. Dorsal view of specimen of ordinary size.

Fig. 1 *b*, *c*, *d*. Ventral, dorsal and profile views of a larger individual.

Fig. 1 *e*. The interior of the ventral valve.

The margins of the area of this and the preceding species are usually prominent or exsert.

Geological position and locality. Limestones of the Lower Helderberg group : Cumberland (Md.).

Spirifer saffordi (n. s.).

PLATE XXVIII. FIG. 2 *a* – *f*.

SHELL rhomboidal ventricose, a little wider than high : valves nearly equally convex. Hinge line about equalling the width of the shell. Ventral valve much elevated and extended towards the beak, which is slightly curved at the apex : sinus subangular, becoming deep towards the front and much produced. Area twice as wide as high, its width being about half the width of the shell. Ventral valve gibbous in

the middle : mesial elevation rounded, moderately prominent. Foramen narrow, the margins exsert.

Surface marked by four, five, or six rounded or obtusely angular plications upon each side of the mesial fold and sinus, concentrically marked by fine closely arranged granulose lamellæ, which are strongly arched upon the central plications.

This species, in its surface markings, resembles *S. cycloptera* and *S. crispus;* but the lamellæ are more closely arranged, and the plications are subangular or less broadly rounded than in those species : the character and proportion of the area and foramen are likewise quite different.

Fig. 2 *a*, *b*, *c*. Dorsal, ventral, and profile views of the same specimen.
Fig. 2 *d*, *e*. Cardinal and front views of the same.
Fig. 2 *f*. Enlargement of the surface.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Becraft's mountain near Hudson; and Decatur county, Tennessee.

Spirifer tenuistriatus (n. s.).

Plate XXVIII. Fig. 3 *a* – *d*.

Shell subrhomboidal, length and breadth about equal; cardinal extremities rounded : valves about equally convex : hinge line less than the width of the shell. Ventral valve much longer than the dorsal, greatest convexity nearly opposite the hinge line, much elevated towards the umbo, with the beak abruptly incurved over the foramen : sinus shallow, curved above, and becoming flat in the bottom towards the base. Area not strongly defined, high, not exceeding half the width of the shell. Dorsal valve semielliptical, most convex in the middle : mesial fold broad, rounded, prominent towards the front.

Surface marked by five or six depressed rounded plications upon each side of the mesial fold and sinus, and which become gradually obsolete towards the margin of the shell; the entire surface covered by extremely fine radiating striæ which are scarcely visible to the naked eye, and these are crossed by finer concentric striæ which crenulate the radiating striæ.

This species belongs to the same group as the preceding; differing from the Niagara *S. radiatus* in its higher area and rounded cardinal extremities, as well as in the depressed rounded folds upon the surface. If, however, we regard the *S. cyrtæna* of DALMAN as identical with the species from the Niagara and Clinton groups, the presence or absence of plications would appear not to be of specific importance. In this one, however, this character is combined with so many others, as to render the distinction very well marked.

Fig. 3 *a*, *b*, *c*. Ventral, dorsal, and profile views.
Fig. 3 *d*. Enlargement of the surface striæ.

Geological position and locality. In shaly limestone, associated with many species common to the Lower Helderberg group : Decatur county, Tennessee.

Spirifer octocostatus (n. s.).

PLATE XXVIII. FIG. 4 *a* – *e*.

SHELL subglobose : valves nearly equally convex. Ventral valve most elevated near the beak : sinus angular, extending to the apex : beak slightly incurved. Dorsal valve most convex in the middle : mesial elevation not prominent : beak rising little above the hinge line, slightly incurved; hinge line less than the width of the shell, rounded at the extremities. Area triangular, faintly defined, somewhat arcuate. Foramen narrow; a strong median septum dividing the muscular area, and extending to the apex of the foramen.

SURFACE having about four rounded moderately prominent folds on each side of the mesial sinus and elevation, which become obsolete towards the beaks; concentrically marked by fine, regular, closely arranged, imbricating lamellose striæ.

This species resembles *S. crispus* of the Niagara group, but is more globose in form, has a much shorter area, more rounded extremities, and less strongly marked plications. It appears to be intermediate between that species and *S. bicostatus* of the same group, but is readily distinguished from either of them.

Fig. 4 *a*, *b*, *c*. Ventral, dorsal, and profile views.
Fig. 4 *d*. Cardinal view, showing the foramen. Fig. 4 *e*. Interior of the ventral valve.

Geological position and locality. Limestones of the Lower Helderberg group : Cumberland (Md.).

Cyrtia dalmani.

PLATE XXIV. FIG. 1 *a* – *y*.

SHELL trigonal : valves extremely unequal. Ventral valve triangularly pyramidal. Dorsal valve semicircular : mesial lobe flat, or with a slightly depressed line : beak scarcely defined, or rising above the hinge line. Hinge line straight. Area triangular, flat or slightly arcuate. Foramen narrow, linear, usually closed in the lower part, with a semi-tubular opening above : concentric lamellæ strong, and often very conspicuous near the margin.

SURFACE granulose-punctate.

This species differs from the *Cyrtia* (*Spirifer*) *pyramidalis* of the Niagara group; having the dorsal valve more uniformly convex, the mesial fold broader and more prominent; while the depressions are not so deep, the mesial sinus is broader, the plications bounding it are less conspicuous, and the concentric imbricating lamellæ are stronger in the species under consideration than in the Niagara species.

I have heretofore referred this species, with doubt, to the *C. heteroclitus* of Europe; for among the variety of forms referred to that species, it is difficult to know the typical one. It differs, however, from the Eifel species of that name.

The illustrations given present a great variety of form and proportions, so that the extremes might readily be regarded as distinct species; but after the examination of a great number of specimens, I am unable to find any reliable characters for their separation.

Fig. 1 *a* – *y*. Illustrations of the ventral, dorsal, profile, and cardinal views of this species, representing the principal varieties of form.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains ; Schoharie, Carlisle, Catskill, Hudson, etc.

GENUS TREMATOSPIRA (n. g.).

[Gr. τρημα, *foramen*; σπειρα, *spira*.]

SHELL transverse, elliptical or subrhomboidal, inequivalve, furnished with internal spires (arranged as in *Spirifer*). Hinge line shorter than the width of the shell : cardinal angles rounded. Valves articulated by teeth and sockets : beak of ventral valve produced or incurved, and truncated by a small round perforation, separated from the hinge line by a deltidium. A deep triangular pit, or foramen, beneath the beak of the ventral valve, which is filled by the closely incurved beak of the dorsal valve. False area sometimes defined.

SURFACE marked either with strong simple plications or finer fasciculate or bifurcating striæ, which cover also the mesial elevation and depression. Shell structure punctate?

In the extension of the hinge line, the mesial sinus, the internal spires, and, partially, in the exterior markings, this genus resembles SPIRIFER and SPIRIFERINA. In the perforate beak, false area, and incurvature of the beak of the dorsal valve beneath the apex of the opposite valve, it resembles ATRYPA; while one of the species has the general aspect of RHYNCHONELLA. From RETZIA, SPIRIGERA, and MERISTA, which have similar internal spires, it is separated by external and other important characters. The appearance of an area is deceptive; depending mainly upon a partial displacement of the valves, which presents to view the hinge line of the ventral valve. This is true of *T. multistriata*, where we find some specimens with an appearance of an area, and others without. The *T. perforata* is clearly without an area, as well as *T. costata;* though the margin of the foramen in the former of these is often defined in such a manner as to resemble a true area. The broad triangular foramen or pit for the reception of the beak of the dorsal valve is a constant and conspicuous feature. This pit does not appear to be like the foramen of *Spirifer*, an opening into the cavity of the valve, but is spoonshaped, somewhat like that of *Pentamerus;* its lateral walls in *T. multistriata* having been traced for some distance below the margins, apparently converging towards each other.

The known species present the variety of surface marking, respectively, of simple costæ, strong angular striæ in fascicles, and finer somewhat rounded bifurcating or simple striæ. Specimens of each are rare; and of *T. costata*, but a single one was found among collections continued uninterruptedly through a period of ten years.

The condition of the specimens is such as not to admit of satisfactory investigations of the interior, which must for the present remain partially undetermined.

The species positively determined to the present time are from the rocks of the Lower Helderberg group; to which may be added the *Trematospira* (*Atrypa*) *camura* of the Niagara group, which presents some slight deviation in the perforation of the beak.

Trematospira perforata (n. s.).

PLATE XXVIII A. FIG. 3 *a* – *i*.

Spirifer? perforatus : HALL, Desc. of New Species of Pal. Fossils, in Regents' Report for 1856.

SHELL somewhat semicircular on the ventral side, with the hinge extremities rounded; hinge line slightly curved : valves nearly equally convex. Ventral valve rhomboidal, with a broad subangular sinus : beak elevated, incurved and truncate at the extremities by a distinct round perforation; a broad triangular pit or foramen beneath the beak. Dorsal valve with beak strongly incurved, and filling the foramen of the opposite valve.

SURFACE marked by sharp radiating striæ, which bifurcate once or twice before reaching the base, presenting fascicles of two or three on the centre of the shell.

This species has the general aspect of *Rhynchonella* ; but the striæ are fasciculate, and the cardinal line more extended. In the perforate beak of the ventral valve, the broad foramen filled with the beak of the dorsal valve, and the internal spires, it resembles the *T. multistriata*, but differs from it in the fasciculate striæ, and in the more elevated and less strongly incurved beak of the ventral valve. The sinus varies from a shallow scarcely defined depression in the young, to a strongly marked angular feature in the older shells.

Fig. 3 *a*. Dorsal view of a small specimen.

Fig. 3 *b*, *c*, *d*. Dorsal, ventral, and profile views.

Fig. 3 *e*, *f*. Dorsal and ventral views of an older specimen with deep sinus.

Fig. 3 *g*, *h*. Front views of a young and old specimen, showing the shallow and deeper mesial sinus.

Fig. 3 *i*. Ventral side of an imperfect specimen, showing the internal spire.

Fig. 3 *k*. Enlargement showing perforated beak and junction of the valves.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains ; and Becraft's mountains, Hudson.

Trematospira multistriata (n. s.).

PLATE XXIV. FIG. 3 *a* – *t*; and PLATE XXVIII A. FIG. 5 *a* – *f*.

Spirifer multistriatus : HALL, Descr. New Species Pal. Fossils, in Regent's Report, etc. 1856.

SHELL transversely oval or subrhomboidal, with angles rounded : hinge line slightly declining on each side of the centre; cardinal extremities rounded. Ventral valve moderately convex towards the beak, with a broad not sharply defined sinus below, which often becomes obsolete before reaching the beak : beak perforate, abruptly incurved over the opposite. Dorsal valve the more convex, the middle elevated in a broad scarcely defined lobe : beak closely incurved beneath the other, filling the foramen in the ventral valve. Area narrow, strongly striated longitudinally.

SURFACE granulose or punctate, and marked by numerous fine striæ which bifurcate once or oftener between the beak and base of the shell, crossed concentrically by imbricating lamellæ of growth.

This species was originally described as a *Spirifer*, from having the appearance of an area, and which is sometimes enhanced by the partial displacement of the valves. A separate valve, fig. 3 *u*, shows obscurely some characters of the ventral valve of *Spirifer*. The junction of the valves and absence of a true area, as well as the insertion of the beak of the dorsal valve beneath the opposite, are well shown in several of the figures.

Fig. 3 *a* – *t*. Illustrations showing gradation of size, variety of form, etc.

Fig. 3 *y*. Enlargement of the striæ.

PLATE XXVIII A.

Fig. 5 *a*. An individual of medium size, having the beaks closely incurved, and without indication of an area.

Fig. 5 *b*. Dorsal view, where the minute perforation in the beak of the ventral valve is barely seen above the summit of the opposite one.

Fig. 5 *c*, *d*, *e*. Ventral, front, and profile views of the same individual.

Fig. 5 *f*. The interior of a ventral valve, showing the remains of internal spires.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains, Schoharie, etc.

Trematospira costata (n. s.).

PLATE XXVIII A. FIG. 4 *a* – *e*.

SHELL transversely elliptical, length less than one-half the width : hinge line slightly declining on each side of the centre; cardinal extremities rounded : valves very moderately convex in the middle, and flattened towards the margins. Ventral valve with a well defined sinus below the middle : beak moderately elevated, incurved, and truncated by a small perforation. Dorsal valve convex in the middle, with a broad scarcely defined mesial fold; cardinal margin thin, and closely pressed to the opposite valve : beak incurved beneath the opposite, and filling a broad pit, leaving on each side an undefined false area on the ventral valve.

SURFACE marked by simple radiating costæ, about fourteen or fifteen (or more) on each valve, three of which are elevated on the mesial fold and two in the depression; the entire surface granulose or punctate, the granules arranged in concentric lines with a few imbricating lamellæ of growth.

This species is well marked by its simple costæ, which cover the mesial fold as well as the lateral portions of the shell. It is extremely extended laterally, and much appressed at the extremities and on the cardinal margins. Without careful examination, this species would readily be mistaken for a *Spirifer* with the area obliterated by pressure.

Fig. 4 *a*, *b*. Dorsal and ventral valves.

Fig. 4 *c*. Profile view.

Fig. 4 *d*. Front view.

Fig. 4 *e*. Enlargement of the surface, showing the granulose punctate character, which is obscure from the silicification of the shell.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains.

Trematospira simplex (n. s.).

PLATE XXVIII A. FIG. 2 *a* – *f*.

SHELL transversely elliptical or subrhomboidal, nearly once and a half as wide as long : hinge line scarcely declining from the beaks; cardinal extremities rounded : valves moderately and almost equally convex, closely compressed at the latero-cardinal margins. Ventral valve having a well defined mesial sinus, which extends more than half way from beak to base : beak elevated, scarcely incurved, and vertically truncated by a small perforation, between which and the hinge line is a well-defined deltidium. Dorsal valve moderately convex in the middle, and slightly elevated towards the front of the shell : beak closely incurved beneath the deltidium of the opposite valve.

SURFACE marked by four or five simple plications on each side of the centre, two of which on the ventral valve are involved in the sinus; and three upon the opposite valve, the central one being broader and flattened towards the base : entire surface granulose or punctate, with faint indications of growth lines.

Trematospira simplex, var.

A larger imperfect specimen, apparently of the same species, has the beak slightly more incurved, the mesial plication depressed in the centre, and those on each side bifurcating near the base, as are those which border the sinus of the ventral valve. The mesial sinus in this specimen is much deeper, and the front of the opposite valve much more elevated.

This species, in its general form, resembles the *T. camura* of the Niagara group; but the shell is somewhat more robust, and the plications are less numerous and stronger. The Niagara species has two smaller plications forming the mesial fold, which often become obsolete before reaching the beak; and the sinus of the ventral valve is often marked by one or two smaller plications, which sometimes extend more than half way to the beak. It differs also from this species in the strong lines of growth, which are seen in many of the specimens. These characters are shown in the figures 3 *k*, *l*, *m*, *n* of Plate LVI, Vol. ii, Palæontology of New-York.

Fig. 2 *a*, *b*. Dorsal and ventral views of the specimen, natural size.

Fig. 2 *c*, *d*. Front and profile view of the same.

Fig. 2 *e*, *f*. Dorsal and front views of a larger specimen, the lateral extremities of which are broken off.

Geological position and locality. In shaly limestone of the age of the Lower Helderberg limestones : Decatur county, Tennessee.

Trematospira camura.

PLATE XXVIII A. FIG. 1 *a* – *h*.

Atrypa camura : Palæontology of New-York, 1850, Vol. ii, pa. 273, pl. 56, f. 3.

SHELL transversely elliptical or subrhomboidal, sometimes depressed subglobose (varying much in form according to age) : valves nearly equally convex. Ventral valve having a narrow well-defined sinus, which is usually marked by one or two plications smaller than those on the lateral portions of the shell, and which become obsolete before reaching the beak : beak elevated, small, acute, slightly incurved, and vertically truncate by a small round or slightly oval perforation, the lower side of which is formed by a well-defined deltidium. Dorsal valve with a scarcely defined mesial fold marked by two smaller plications, which usually become obsolete before reaching the beak : beak closely incurved beneath the deltidium.

SURFACE marked by about four, five, or six plications on either side of the mesial fold and sinus, and concentrically crossed by imbricating lines of growth, with the entire surface granulose or punctate.

This species varies considerably in its form and proportions; being sometimes depressed globose, with length and width about equal, while the prevailing forms have the width nearly one-half greater than the length. In a single individual, which does not appear to have been distorted, the width is twice as great as the length. In all these variations, it preserves the characteristic surface markings.

Fig. 1 *a*. Dorsal view of a specimen of medium size.

Fig. 1 *b*. Ventral view of the same, showing a single small plication in the mesial sinus.

Fig. 1 *c*. Front view of the same.

Fig. 1 *d*. Profile view of the same.

Fig. 1 *e*. Enlargement of the beak, foramen and deltidium of the ventral valve, and the upper part of the dorsal valve.

Fig. 1 *f*. Dorsal view of a shorter specimen, which has been cut transversely to show the internal spires.

Fig. 1 *g*. Enlargement of plications, showing granulose surface and strong imbricating lines of growth.

Fig. 1 *h*. Surface of plications enlarged, showing granulose surface without imbricating lines of growth.

Geological position and locality. In the shale of the Niagara group, Lockport.

The illustrations given upon Plate XXVIII A comprise all the species of this genus which had been positively determined up to the present time. The geological range, so far as known, is extremely limited; these species occurring in the Niagara and Lower Helderberg groups only. There are one or two forms in the Upper Helderberg limestones, of which I possess imperfect specimens, which may perhaps come under this generic designation; but I have not yet determined their true relations.

The species described are for the most part of rare occurrence, that of the Niagara group being the most abundant; while of *T. simplex*, I have seen only two specimens; of *T. perforatus*, five specimens; of *T. costatus*, one specimen, and of *T. multistriatus*, about fifteen; and it should be recollected that the three last named are the result of about fourteen years collecting in the Helderberg mountains, during ten years of which time several persons were constantly occupied in gathering fossils in that locality, many species of which are numbered by thousands of individuals.

The *T. camura*, occurring in the Niagara group, is almost synchronous with the first appearance of SPIRIFER; *S. radiatus* occurring in the upper limestone of the Clinton group, below the Niagara shale, and in the latter rock also in the same association with TREMATOSPIRA.

TREMATOSPIRA : SUBGROUP RHYNCOSPIRA.

THE following species were originally referred to RHYNCHONELLA; but in the arrangement of the plates of the third volume some years since, I had placed together the three species *R. globosa*, *R. formosa* and *R. deweyi*, believing them to be distinct from true *Rhynchonellæ*. The condition of the specimens was such that up to 1856 I had not been able to discover the internal structure of any of them, and at that time referred them with much hesitation to WALDHEIMIA; and they were so published in the Report of the Regents of the University for that year. While this

volume has been passing through the press, a careful review and re-examination of the specimens has enabled me to discover the existence of internal spires, which, from the displacement of those first examined, appeared to be arranged as in *Atrypa;* while farther examinations show that these appendages are arranged as in *Spirifer* and *Trematospira.*

The *T. globosa* and *T. formosa* have so much resemblance to RETZIA in general form and exterior markings, that they might readily be mistaken for species of that genus; but they have no area or extension of the hinge line, which is almost always conspicuous on the dorsal valve of *Retzia.* The shells of the latter are more finely striated and finely punctate throughout, while we are able to distinguish only a granular or punctate surface in *Trematospira.*

In the United States, the Genus RETZIA is yet unknown below the Carboniferous limestone.

Had the materials now possessed been originally studied altogether, the whole, by some extension of the characters, might have been included in the same designation; but it is only since the description of the genus has been printed, that I have obtained the means of showing the similarity of structure.

The following species, except *T. deweyi*, differ from those already described, in being more extended like *Rhynchonella*, the beak strongly incurved, and the lateral slopes below the beak flattened or depressed as in that genus.

The perforation of the beak, arrangement of the spire, and granular or apparent punctate structure of the shell of the following species, correspond with the preceding species of *Trematospira.* The triangular depression beneath the beak, which in *T. multistriata* appears not to open into the cavity of the shell, is probably not a real character; since in these species it is clearly an opening into the interior, the beak of the dorsal valve being slightly inserted and held in place by a broad short cardinal process which is clasped at base by the cardinal teeth of the opposite valve. This intimate structure of the hinge has not been fully made out in the preceding species of *Trematospira;* and should it hereafter be found identical, the two groups may be united by some extension of the generic characters.

From the general resemblance in external form and plicated surface of these shells to *Rhynchonella*, it is not improbable that some species referred to that genus may prove identical with those now under consideration.

For illustrations of the internal structure of those species described on Plate XXXVI, and for *T. rectirostra*, see Plate XXXVI A.

Trematospira globosa (n. s.).

PLATE XXXVI. FIG. 1 *a* – *p*.

Waldheimia globosa : Descr. of New Species of Pal. Fossils, in Regents' Report for 1856, p. 47.

SHELL subglobose or ovoid. Ventral valve a little larger and slightly less gibbous than the opposite one, most gibbous in the umbonial region : beak prominent, rounded and arched, perforate at the extremity by a round aperture, the lower side of which is formed by a deltidium. Dorsal valve shorter than the ventral, very gibbous in the middle : beak incurved.

SURFACE marked by twelve to sixteen somewhat angular plications on each valve, two or three of which are slightly depressed on the middle so as to produce, sometimes, a faint emargination in front; the depressed plications smaller than the others, and often becoming obsolete before reaching the beak. A few strong concentric imbricating lines of growth cross the plications : shell granulose.

The globose form and elevated subangular plications of this shell, as well as the generally more distinctly imbricating lamellæ, giving it a rude form, will serve to distinguish it from the following species of the same rock.

Fig. 1 *a* – *e*. Dorsal, profile, and front views of young individuals.

Fig. 1 *f* – *k*. Individuals of larger size.

Fig. 1 *l* – *p*. Individuals of full size, showing some differences in the plications, and in the elevation of the beak.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains, Albany county.

Trematospira formosa (n. s.).

PLATE XXXVI. FIG. 2 *a* – *t*.

Waldheimia formosa : Descr. of New Species of Pal. Fossils in Regents' Report for 1856, p. 48.

SHELL longitudinally ovate. Ventral valve tapering towards the beak : beak prominent, rounded, arched or incurved, truncated at the apex by a round perforation, one side of which is formed by the deltidium. Dorsal valve gibbous, sometimes most prominent near the umbo : beak closely incurved beneath the opposite one.

SURFACE marked by eighteen to twenty-two or twenty-three simple rounded or rarely subangular plications, two or three of which are much smaller and slightly depressed on the middle of each valve, so as to form a faint narrow sinus extending nearly or quite to the apex of the beaks, and giving a slight emarginate outline to the front. Surface marked by fine imbricating concentric lines of growth, which become strong lamellæ towards the margins of the shell : shell granulose.

This species differs from the preceding in its more elongate form, larger size of full-grown individuals, and less rugose imbricating lines of growth. The plications are less strongly developed and more numerous, and the central ones become obsolete or nearly disappear before reaching the beak.

There are rarely individuals, as fig. 2 *f* of Plate XXXVI, which approach more nearly in character to the preceding species; but they are always less rotund in form, and the beak larger.

Fig. 2 *a* – *e*. Young shells of this species, the plications fine and equal.

The foramen is represented as extending below the beak, and having a triangular form from the absence of the deltidium : this, however, is an accidental condition, as the young shells frequently preserve the deltidium entire, and present the round perforation as in the beak of old shells.

Fig. 2 *f*. An individual having strong angular striæ more like the preceding species, but with the elongate form and narrow beak characteristic of this one.

Fig. 2 *g* – *k*. Dorsal, profile, and front views of specimens of the ordinary size.

Fig. 2 *l* – *t*. Individuals of larger size and very symmetrical form.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains, Albany county.

Trematospira deweyi (n.s.).

PLATE XXXVI. FIG. 3 *a* – *k*.

Waldheimia deweyi : Descr. of New Species of Pal. Fossils in Regents' Report for 1856, p. 49.

SHELL depressed subglobose, sometimes subquadrilateral with the sides curving : valves nearly equal. Ventral valve a little the most prominent towards the umbo, having a narrow faint sinus from near the beak to the front, where it sometimes produces a slight sinuosity : beak perforate, extending a little above the opposite beak, upon which it is closely incurved. Dorsal valve symmetrically arched, without mesial elevation.

Surface marked by about forty regular simple rounded striæ, which are crossed by indistinct lines of growth, and, near the front, by a few stronger imbricating concentric marks indicating interrupted stages of growth : shell granulose.

This shell has the general form of *Atrypa reticularis;* but the surface is marked by fine regular simple striæ, two or more of those occupying the mesial sinus of the ventral valve becoming obsolete before reaching the beak.

Fig. 3 *a, b, c, d.* Dorsal, ventral, profile, and front views of a very perfect specimen of medium size.

Fig. 3 *e, f, g.* Ventral, dorsal, and profile views of a larger specimen, the sides of which slope more rapidly from the beak.

The entire collections made during a period of fourteen years have yielded but ten individuals of this species.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains, Albany county.

Trematospira rectirostra (n. s.).

Plate XXXVI A. Fig. 1.

Waldheimia rectirostra : Descr. of New Species of Pal. Fossils in Regents' Report for 1856, p. 49.

Shell longitudinally ovate, tapering towards the beak, slopes on each side of the beaks, flattened and not plicated. Beak of ventral valve straight, extending much beyond the opposite, truncated at the apex by a round perforation, which is partly limited by the deltidium : beak of dorsal valve incurved, and penetrating the opposite valve.

Surface marked by twelve or thirteen prominent subangular plications, the two central of which, on the ventral valve, are slightly smaller than the others, and a little depressed. These two plications coalesce before reaching the beak : the central plication of the dorsal valve is smaller and a little more depressed than the others, and becomes obsolete before reaching the beak.

This well-marked species may be at once distinguished from either of the preceding by its less ventricose form, and the more attenuated and straight beak of the ventral valve.

Fig. 1 *a, b, c.* Dorsal, ventral, and profile views.

Fig. 1 *d.* Cardinal view, showing the foramen.

Geological position and locality. Oriskany sandstone, Maryland.

ECCLEOSPIRA.

In Murchison's Silurian System Mr Sowerby has described under the same Spirifer? genus, a species differing essentially in general external characters from the typical forms of that genus. This species has been adopted as a true Spirifer in Morris's Catalogue of British Fossils, and in the Synonymica Palæozoica of Bronn, as well as elsewhere. Subsequently I discovered in the Niagara shales a form so similar to the British species, that I regarded it as identical: but, from the condition and character of the specimens, I considered them as more nearly allied to Orthis than to Spirifer, and, accordingly, in the second volume of the Palæontology of New-York, designated the Niagara fossil Orthis plicata.

Since that period, my collections from the Helderberg have revealed a species similar to the one from the Niagara group; but among the numerous individuals from the latter rocks, I found several which were clearly furnished with internal spires like the true *Spirifer*, thus separating it from *Orthis* by unequivocal characters. Finding no genus for the reception of these forms, I described the latter as *Spirifer centricosa;* and it has been so published in my descriptions of new palæozoic fossils in the Report of the Regents of the University upon the State Collections of Natural History.

Farther examination has satisfied me of the impropriety of placing this fossil under either of the genera named, for several reasons. The central depressed line, or narrow sinus, which might be regarded as the mesial sinus of *Spirifer*, is almost equally a character of both valves; the apparent area is not a true area; and the apparent foramen, being merely a depression in the false area, does not correspond to the foramen either of *Spirifer* or of *Orthis*, not opening into the cavity of the shell. The hinge line is not extended in the manner of these shells, particularly of the former; while the presence of a spire sufficiently distinguishes it from the latter.

The Lower Helderberg group furnishes one, and perhaps two, other

species; and I find that the fossil described by me as *Atrypa concinna* in the Report of the Fourth Geological District (1843), is another species belonging to the same group of fossils, in which both the external characters and internal structure differ so essentially from any of the described genera of Brachiopoda as to constitute a distinct genus; and which, from the general nucleolar character of the known species, I propose to designate NUCLEOSPIRA.

GENUS NUCLEOSPIRA (n. g.).

[Gr. κυρην, *nucleus*; σπειρα, *spira*.]

SHELL spheroidal or transversely elliptical, more or less gibbous or ventricose, furnished with internal spires as in *Spirifer* : hinge line shorter than the width of the shell; cardinal extremities rounded : valves subequal, articulating by teeth and sockets. Ventral valve having the beak extended beyond the opposite valve, and beneath it a triangular depression or area, which sometimes terminates in a shallow spoon-shaped pit; on each side of which, at the base, is a strong tooth : a narrow ridge or septum extends along the centre of the inner side of the valve, from beak to base. Dorsal valve furnished with a strong spatulate cardinal process, which, rising vertically from the cardinal margin, is closely grasped at its base by the cardinal teeth of the other valve; and thence bending abruptly upwards, and expanding, is projected into the cavity of the opposite beak, lying close upon the under side of the false area. This process is grooved or depressed in the centre of the upper side, so as to leave between it and the arch of the ventral beak a narrow space for the passage of a pedicle, for the protrusion of which a minute foramen is sometimes observed in the beak. From the sides of this process, above the junction of the teeth of the opposite valve, and at the point where it bends upwards, originate the brachial processes which support the spires. A deep cavity beneath the cardinal process extends to the dorsal beak, from which originates a thin

elevated septum running to the base of the shell. Muscular imprints confined to a narrow oval space.

SURFACE apparently smooth : shell structure punctate, and, when perfect, covered with minute hair-like spines.

The larger species of this genus present some analogy in external appearance with *Spirigera*, and the presence of internal spires increases the similarity. The cardinal teeth resemble those of *Spirigera* and *Merista* : the punctate shell and the structure of the hinge are, however, quite different. In form, and in the punctate character, it simulates *Magas;* while the elongate cardinal process of the dorsal valve resembles that organ in *Thecidium*. The genus, however, when regarded in all its features, is very distinct from any of these; and the species will constitute, so far as regards American palæozoic brachiopoda at present known, a well-marked, beautiful, and interesting little group. The geological range at present known extends from the Niagara, through the Lower Helderberg, to the Hamilton; though it is probable we shall find them in other strata.

Nucleospira ventricosa (n. s.).

PLATE XIV. FIG. 1; and PLATE XXVIII B. FIG. 2 – 9.

SHELL globose : valves almost equally convex. Ventral valve having a narrow sinus extending down the centre from beak to base : beak projecting above the other, strongly incurved and pointed (in many specimens the beaks are nearly equal). Dorsal valve having a central depressed line, which is less conspicuous than in the opposite valve : false area very small, concave.

SURFACE marked by concentric lines of growth; and, when perfect, covered with minute hair-like spines, which, when removed, leave a punctate surface.

The interior of the dorsal valve shows a faintly defined muscular area, a longitudinal septum, and prominent recurved cardinal process, with an accessory process on each side for the attachment of the spires. The ventral valve shows a longitudinal septum similar to that of the opposite valve, with a more or less strongly defined muscular depression; area, or false area, a concave triangular space, over which the acute beak is arched. In well-preserved specimens, the beak appears to be minutely

perforate upon the under side. Internal spires, as in *Spirifer*, showing ten or twelve turns on each side.

These shells are rarely or never found in separated valves, like most of the other Brachiopoda; and the cause of this is clearly discernible, when we know the character of the hinge in which the recurved cardinal process extends into the curved beak of the opposite valve, while its narrow base is closely clasped by the curved teeth of the ventral valve, forbidding any dislocation of the two valves without a fracture of the parts. The extent to which this cardinal process penetrates beneath the beak of the ventral valve may be seen by carefully breaking away the shell of that valve below the beak; which, if skilfully performed, will leave the spoonshaped process projecting beyond the shell.

This species resembles *Nucleospira pisiformis* of the Niagara group; but the form is slightly more extended, the beak of the ventral valve more elevated and incurved, and the false area more distinct. It varies in size from the dimensions of fig. 1 *a* to *h*; usually presenting a very rotund form, but not unfrequently compressed as in fig. 1 *g* and *h*, and sometimes extremely ventricose as in 1 *i*, *k*.

Fig. 1 *a*, *b*, *c*. Individuals of small size.
Fig. 1 *d*, *e*. Casts of larger forms.
Fig. 1 *f*, *g*, *h*. Specimens of large size.
[The figures 1 *l* – *o* do not belong to this species.]

PLATE XXVIII B.

Fig. 2 *a*, *b*, *c*. Illustrations of a form having the beak more elevated than usual.
Fig. 3 *a*, *b*. The ordinary form of this species.
Fig. 3 *c*, *d*. An individual preserving the remains of the fine hair-like spines which cover the surface of perfect specimens.
Fig. 4 *a*, *b*. A cast of the interior.
Fig. 5. The interior of a ventral valve preserving the internal spires.
Fig. 6 *a*. The dorsal valve, showing the extended cardinal process and the longitudinal septum.
Fig. 6 *b*. Profile of the same.
Fig. 6 *c*, *d*. Enlargement of the preceding figures.
Fig. 7 *a*, *b*. Interior of the ventral valve, and profile view of the same.
Fig. 8. Interior, showing the articulation of the valves; *t*, *t*, the cardinal teeth; *J*, the cardinal process; *B*, *B*, the brachial processes.
Fig. 9. Diagram showing a longitudinal section of the valves, the articulating teeth, the cardinal process, spire, and longitudinal septa *s*, *s*.

Geological position and locality. In the shaly limestone of the Lower Helderberg group: Helderberg mountains, Schoharie, Cherryvalley, in New-York; Cumberland in Maryland, etc.

Nucleospira elegans (n. s.).

PLATE XXVIII B. FIG. 10 – 15.

SHELL suborbicular, wider than long. Ventral valve gibbous, particularly towards the umbo, with a flattened or sometimes depressed mesial line down the centre : beak elevated above that of the opposite valve, and incurved; area sometimes well defined. Dorsal valve depressed convex, somewhat gibbous towards the beak, with a narrow depressed mesial line above, which becomes a broad depression below, producing a gentle sinuosity in the outline of the front : beak small, closely incurved beneath the beak of the opposite valve.

SURFACE of shell finely and beautifully punctate, and sometimes preserving remains of the pilose covering.

This species is distinguished from the preceding by its larger size, greater proportional width, unequal convexity of the valves, and the broad scarcely defined depression towards the base of the dorsal valve. A single large specimen, which is more depressed than usual towards the base of the dorsal valve, has a width of almost three-fourths of an inch by a length of half an inch. In the ordinary apparently full-grown specimens, the length and breadth are about as four to five.

From the form of this species, and from the much greater convexity of the ventral valve and the apparent area, it may be mistaken for *Orthis*, which it much resembles, more particularly when the valves are a little separated at the hinge line. It may be readily distinguished by the punctate surface, absence of striæ, and, internally, by the presence of spires.

The internal spires, not only of this species, but of the *N. ventricosa*, frequently appear to be displaced, or to lie obliquely in the valves. In fig. 14, the turns of the spire are vertical to the direction of the valves, the view being from the ventral side.

Fig. 10 *a*, *b*. Dorsal and ventral views of a very symmetrical specimen of the ordinary size, showing slight indications of the central flattening or depression. (From the Helderberg mountains.)

Fig. 10 *c*, *d*. Front and profile views.

Fig. 11 *a*, *b*. Dorsal and ventral views of a specimen which is proportionally broader. (From the Lower Helderberg group, Maryland.)

Fig. 12 *c*. Dorsal view of a specimen without mesial depression, and showing an extension in front.

Fig. 13 *a*, *b*. Dorsal and front views of a large individual which is proportionally very broad and deeply depressed in front, showing a broadly sinuate outline.

Fig. 14. Ventral valve, showing the spire on one side displaced.

Fig. 15. Dorsal valve, showing the spires arranged transversely as in *Spirifer*.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Base of the Helderberg mountain, Cherryvalley, N. York; and Cumberland in Maryland.

Nucleospira concentrica (n. s.).

PLATE XXVIII B. FIG. 15 – 19.

SHELL depressed orbicular, or sometimes scarcely subrhomboidal in outline : valves almost equally convex. Ventral valve subangular in the middle towards the beak, sometimes a little depressed towards the front : beak elevated above the opposite valve, acute, incurved, perforate at the apex. Dorsal valve having a central longitudinal depressed line, most convex in the middle and depressed at the beak, which is closely incurved beneath the opposite one.

SURFACE, when perfect, covered by minute hair-like spines; the shell punctate, and marked by conspicuous laminæ of growth.

This species differs from the *N. pisiformis* and *N. ventricosa*, by having the beak of the ventral valve a little more prominent; while the centre of the shell, from the beak half way to the base, is obtusely angular. The central depressed line, which marks the other species, is sometimes shown towards the base of the ventral valve, while it is a distinguishing feature of the dorsal valve. The elevation of the beak, and the conformity of the cardinal slopes of both valves to this feature, gives an outline to the shell less regularly curved than those mentioned. The concentric laminæ are often very regular, and much more conspicuous than on either of the other species observed. The latter feature, together with the elevated subangular beak, are distinguishing characteristics of the shell.

Fig. 16 *a*, *b*, *c*. Dorsal, ventral, and profile views of a small individual, from which the pilose covering has been removed.

Fig. 16 *d*. Enlargement of the dorsal side, showing more distinctly the subrhomboidal form and the concentric laminæ of growth. The perforation of the beak appears to have been somewhat enlarged by fracture, but this feature is conspicuous in all the specimens of this species.

Fig. 17 *a*, *b*. Dorsal and profile views of a more gibbous specimen.

Fig. 18 *a*. Enlargement of the surface preserving the pilose or fibrous exterior, which in this instance appears to be a thickened fibrous covering of the shell.

Fig. 18 *b*. Enlargement of the surface, from which the exterior covering is removed.

Fig. 19. A transverse section of a specimen, showing the internal spires.

Geological position and locality. In shaly limestone of the age of the Lower Helderberg group : Decatur county, Tennessee.

Nucleospira elegans (n. s.).

PLATE XXVIII B. FIG. 10 – 15.

SHELL suborbicular, wider than long. Ventral valve gibbous, particularly towards the umbo, with a flattened or sometimes depressed mesial line down the centre : beak elevated above that of the opposite valve, and incurved; area sometimes well defined. Dorsal valve depressed convex, somewhat gibbous towards the beak, with a narrow depressed mesial line above, which becomes a broad depression below, producing a gentle sinuosity in the outline of the front : beak small, closely incurved beneath the beak of the opposite valve.

SURFACE of shell finely and beautifully punctate, and sometimes preserving remains of the pilose covering.

This species is distinguished from the preceding by its larger size, greater proportional width, unequal convexity of the valves, and the broad scarcely defined depression towards the base of the dorsal valve. A single large specimen, which is more depressed than usual towards the base of the dorsal valve, has a width of almost three-fourths of an inch by a length of half an inch. In the ordinary apparently full-grown specimens, the length and breadth are about as four to five.

From the form of this species, and from the much greater convexity of the ventral valve and the apparent area, it may be mistaken for *Orthis*, which it much resembles, more particularly when the valves are a little separated at the hinge line. It may be readily distinguished by the punctate surface, absence of striæ, and, internally, by the presence of spires.

The internal spires, not only of this species, but of the *N. ventricosa*, frequently appear to be displaced, or to lie obliquely in the valves. In fig. 14, the turns of the spire are vertical to the direction of the valves, the view being from the ventral side.

Fig. 10 *a*, *b*. Dorsal and ventral views of a very symmetrical specimen of the ordinary size, showing slight indications of the central flattening or depression. (From the Helderberg mountains.)

Fig. 10 *c*, *d*. Front and profile views.

Fig. 11 *a*, *b*. Dorsal and ventral views of a specimen which is proportionally broader. (From the Lower Helderberg group, Maryland.)

Fig. 12 *c*. Dorsal view of a specimen without mesial depression, and showing an extension in front.

Fig. 13 *a*, *b*. Dorsal and front views of a large individual which is proportionally very broad and deeply depressed in front, showing a broadly sinuate outline.

SURFACE ornamented by twenty-eight to thirty-two simple rounded plications, broader than the depressions between. On the dorsal valve the central depression is a little deeper than the others, extending quite to the beak : fine concentric lines, which arch a little upwards, cross the plications.

This species may be compared with *Terebratula haidingeri* of BARRANDE, to some varieties of which it bears considerable resemblance : it is, however, generally less gibbous, and the beak of the ventral valve is much less prominent. The concentric undulations, marking the stages of growth, are likewise more faint than in BARRANDE'S species.

I have some doubts whether this fossil is a true *Rhynchonella;* but the species is extremely rare, and has thus far afforded me no opportunity of studying the interior structure.

Fig. 2 *a*, *b*, *c*. Young individuals of this species.

Fig. 2 *d*, *e*, *f* & *h*. Dorsal, ventral, profile, and front views of a larger individual.

Fig. 2 *i*. Enlargement of the concentric striæ.

Fig. 3 *a*, *b*, *c*. An individual having a shorter and more rotund form, with a faintly marked sinus in front. This is probably a distinct species.

Geological position and locality. In the lower pentamerus limestone of the Lower Helderberg group : Helderberg mountains, Albany county.

Rhynchonella mutabilis (n. s.).

PLATE XXIX. FIG. 4; and PLATE XXX. FIG. 1 & 2.

SHELL varying from ovate to spherical. Ventral valve sometimes depressed, generally most convex in the umbonial region : beak small, pointed, closely incurved over that of the opposite valve. Dorsal valve gibbous : beak incurved beyond the hinge line; cardinal border on each side of the beak, concave.

SURFACE marked by twenty to twenty-six depressed rounded simple plications, of which about six or eight are slightly raised towards the front of the dorsal valve into an indistinct mesial elevation; and five or six depressed near the front of the ventral valve, and extended into a short linguiform prolongation; concentrically marked by fine undulating striæ ?

Rhynchonella semiplicata.

PLATE XXIX. FIG. 1 *a* – *o*.

Atrypa semiplicata : CONRAD, Annual Report on the Palæontology of New-York, 1841, p. 56.

SHELL (in the young state) compressed ovate, becoming more gibbous and subtriangular : valves nearly equal. Ventral valve slightly more gibbous, most prominent in the middle, and having towards the front a more or less defined mesial sinus, in which there are from one to two plications, while from one to three lateral plications occupy the space on each side of the sinus : beak closely incurved over that of the opposite valve. Dorsal valve depressed convex, having from two to four rounded plications on each side of the medial fold, which is itself bifid or trifid : plications strongly marked in front, and usually becoming obsolete near the middle of the valve.

SURFACE having traces of extremely fine radiating striæ, crossed by concentric undulations of growth. In the young state, the surface is free from plications, showing only fine concentric striæ.

This shell is frequently abundant in the lower part of the Pentamerus limestone, associated with *Pentamerus galeatus* and *Strophodonta punctulifera*.

Fig. 1 *a*, *b*, *c*. Young individuals which are nearly smooth, or with faint undulations towards the front.

Fig. 1 *d*, *e*. A small individual having the front extremely plicated.

Fig. 1 *f* – *n*. Illustrations of the prevailing forms, variety of plication, etc.

Fig. 1 *o*. Enlargement of the surface, showing the concentric and longitudinal striæ.

Geological position and locality. In the lower pentamerus limestone of the Lower Helderberg group : Helderberg mountains, Schoharie, Carlisle, etc.

Rhynchonella æquivalvis (n. s.).

PLATE XXIX. FIG. 2 *a* – *i*; and FIG. 3 *a*, *b*, *c*.

SHELL ovate, somewhat compressed : sides sloping from the beaks at a little less than a right angle; front semicircular : valves nearly equally convex. Ventral valve having sometimes, towards the front, a broad very faint depression or sinus : beak pointed and incurved.

SURFACE ornamented by twenty-eight to thirty-two simple rounded plications, broader than the depressions between. On the dorsal valve the central depression is a little deeper than the others, extending quite to the beak : fine concentric lines, which arch a little upwards, cross the plications.

This species may be compared with *Terebratula haidingeri* of BARRANDE, to some varieties of which it bears considerable resemblance : it is, however, generally less gibbous, and the beak of the ventral valve is much less prominent. The concentric undulations, marking the stages of growth, are likewise more faint than in BARRANDE's species.

I have some doubts whether this fossil is a true *Rhynchonella;* but the species is extremely rare, and has thus far afforded me no opportunity of studying the interior structure.

Fig. 2 *a*, *b*, *c*. Young individuals of this species.

Fig. 2 *d*, *e*, *f* & *h*. Dorsal, ventral, profile, and front views of a larger individual.

Fig. 2 *i*. Enlargement of the concentric striæ.

Fig. 3 *a*, *b*, *c*. An individual having a shorter and more rotund form, with a faintly marked sinus in front. This is probably a distinct species.

Geological position and locality. In the lower pentamerus limestone of the Lower Helderberg group : Helderberg mountains, Albany county.

Rhynchonella mutabilis (n. s.).

PLATE XXIX. FIG. 4; and PLATE XXX. FIG. 1 & 2.

SHELL varying from ovate to spherical. Ventral valve sometimes depressed, generally most convex in the umbonial region : beak small, pointed, closely incurved over that of the opposite valve. Dorsal valve gibbous : beak incurved beyond the hinge line; cardinal border on each side of the beak, concave.

SURFACE marked by twenty to twenty-six depressed rounded simple plications, of which about six or eight are slightly raised towards the front of the dorsal valve into an indistinct mesial elevation; and five or six depressed near the front of the ventral valve, and extended into a short linguiform prolongation; concentrically marked by fine undulating striæ?

The plications on this shell are usually simple, though in a few specimens one or two of them are seen to bifurcate. The surface of perfect specimens would probably show fine concentric lines; but those hitherto found, have such markings only near the margins of the valves. As is usual in this type of *Rhynchonella*, the plications in front and at the sides are marked with a central impressed line towards the margins of the valves.

In form and general aspect this species varies greatly, being sometimes longitudinally ovate or oblong, in others globose and subpentagonal. The extremes of these varieties, without the intermediate forms, would appear to present well-marked specific differences; but a careful study of the series shows such an imperceptible gradation of form as to leave no doubt of their identity.

The cast of the ventral valve shows a strongly marked ovate muscular imprint, the details of which, and of the accessory parts, vary in individuals of different forms and proportions.

PLATE XXIX.

Fig. 4 *a* – *c*. Young shells having a more elongate form than the prevailing types.

Fig. 4 *d* – *k*, and *p*. The shorter form of this shell in the smaller individuals.

Fig. 4 *l* – *o*. The ovoid forms of this species.

PLATE XXX.

Fig. 1 *a* – *e*. Ovoid forms of this species.

Fig. 2 *a*, *b*, *c*. Profile views of the more gibbous forms, showing the gradual expansion of the dorsal valve.

Fig. 2 *d*, *e*. Front and dorsal views of a very gibbous form.

Fig. 2 *f* – *q*. Illustrations of extremely gibbous forms, which sometimes present a subquadrangular outline, and some variation in the form of the broad extension of the mesial sinus in front, and in the proportional length and breadth of the dorsal valve as shown in figures 2 *l* and 2 *o*. The form 2 *n* is rare, but is nevertheless one which the species sometimes assumes.

The preceding figures of Plate XXIX and Plate XXX represent a series of forms, which can be traced from the smaller to the larger individuals through uninterrupted gradations. This variation is not confined to this species alone, but I have found other species of the genus, when examined in extensive collections, to be represented by a more elongate and a more gibbous and rotund form.

Fig. 2 *a*, *b* and *c* represent the changing direction of the line of junction in the two valves, and the increasing ventricosity of the dorsal valve; while the ventral valve retains more nearly its original form, and is sometimes even proportionally less gibbous than in smaller forms. The larger specimens are nearly all from the Pentamerus limestone, and have the shell partially exfoliated, so that the finer details of surface marking are not preserved.

Geological position and locality. In the lower pentamerus limestone of the Lower Helderberg group : Helderberg mountains, Schoharie, Carlisle and other places.

Rhynchonella nucleolata (n. s.).

PLATE XXXI. FIG. 1 & 2.

SHELL varying from spherical to spheroid-pentagonal or subpentagonal. Ventral valve convex or depressed convex, abruptly deflected towards the margins : beak small, depressed, closely incurved over that of the opposite valve, often subangular on its lateral margins. Dorsal valve larger, sometimes very gibbous, often a little depressed towards the beak : beak never prominent.

SURFACE marked by fifteen to twenty-three simple rounded plications, about four or five of which are slightly elevated towards the front of the dorsal valve into a mesial prominence, and three to five depressed on the ventral valve, so as to form a more or less distinct sinus, which never extends beyond the middle of the shell. These depressions are prolonged in front into a more distinct linguiform extension fitting into a corresponding sinus in the front of the opposite valve, and sometimes curved inwards beyond the plane of a right angle with the back of the valve.

This species is perhaps more nearly related to *Rhynchonella* (*Terebratula*) *wilsoni*, than any other species in the rocks of New-York. Indeed the analogy between this one and some of the forms referred to that species is so great, that until the limits of variation to which it is subject are better defined, it is scarcely possible to point out characters by which they can always be distinguished.

The species under consideration differs from authentic specimens of *R. wilsoni*, from Dudley, England, in being uniformly more coarsely plicated, and usually more angular in outline. When compared with specimens of the same species from Bohemia, these differences are not so conspicuous.

An analogous or representative species, from the same geological position in Tennessee, has finer plications, of which, six, seven or eight are often elevated on the front of the dorsal valve, while there are frequently as many as twelve or fourteen on each side of the mesial sinus.

This species corresponds almost precisely with the English specimens which come to us labelled "*Terebratula wilsoni*."

It is possible that the figures 1 *a*, *b*, *c* of Plate XXXI are distinct from those which

follow; but I have not been able to find reliable characters for separation, among a large number of specimens.

This species resembles *R. mutabilis* in form, but may be distinguished by its more angular and more strongly elevated plications, of which there are fewer on the mesial sinus and elevation.

Fig. 1 *a*, *b*, *c*. A young individual and one of medium size, having smaller plications than usual, and a larger number upon the mesial sinus.

Fig. 1 *d*, *e*, *f*. Larger individuals, having stronger plications than the preceding, and a larger number upon the mesial fold and sinus than those which follow.

Fig. 2 *a* – *e*. Figures presenting the ordinary character of the smaller individuals of this species.

Fig. 2 *f* – *t*. Illustrations of the gradations in size, form, and proportions of this species.

Fig. 2 *u*, *x*, *y*. A cast of this species, showing the form of the muscular impression in the ventral valve, the median plate of the dorsal plate, and the alveolar cavities.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains, Schoharie, Carlisle and other places.

Rhynchonella abrupta (n. s.).

PLATE XXXI. FIG. 3.

SHELL transversely oval, subpentagonal. Ventral valve depressed convex, very abruptly deflected towards the opposite valve on the lateral margins : beak small, depressed on the outside and subangular along its lateral slopes, closely incurved over that of the opposite valve. Dorsal valve much the larger, very prominent in front, obliquely declining towards the beak : beak depressed, incurved.

SURFACE ornamented by from twenty-five to thirty-three simple subangular plications, seven or eight of which are elevated towards the front of the dorsal valve into a somewhat distinct mesial prominence, and from six to eight of those on the middle of the ventral valve are depressed so as to form a broad undefined sinus, which scarcely extends beyond the centre of the valve towards the beak, but is prolonged in front, and abruptly bent upwards nearly at right angles to the dorsal valve into a distinct linguiform extension. The plications are marked in front by the usual longitudinal depressed line along the centre of each, and extremely fine regular zigzag lines corresponding to the

sharp interlocking edges of the front and lateral margins of the valves. These fine striæ doubtless represent lines of growth, which have become wholly obsolete on other parts of the shell.

In this species the two plications bounding the sinus of the ventral valve, and the mesial elevation of the dorsal, sometimes bifurcate towards the beak or middle of the valves, one becoming obsolete on the front. It resembles some of the Bohemian forms which are considered varieties of *R. wilsoni*, but is a larger and relatively broader shell, the mesial elevation is more distinct, and the general form is less rotund. It is possible that more extensive collections may prove this species to be an extreme variety of the preceding.

Fig. 3 *a*, *b*. Dorsal and ventral views of a well-marked individual of this species.
Fig. 3 *c*, *d*. Front and cardinal views of another individual.

Geological position and locality. Shaly limestone of the Lower Helderberg group, Albany and Schoharie counties.

Rhynchonella pyramidata (n. s.).

PLATE XXXII. FIG. 1 & 2.

SHELL pyramidal, subpentagonal; outline subquadrangular. Ventral valve nearly flat or depressed convex, more or less abruptly deflected at the margins towards the other valve : beak prominent, flattened, and closely incurved over that of the opposite valve. Dorsal valve very gibbous, declining from near the front towards the beak : beak angular, incurved, flattened; lateral slopes with a distinctly impressed suboval space beneath the beaks, which is bounded by an angular fold extending from the beak downwards to the margin of the valve at the first strong plication.

SURFACE marked by from thirteen to twenty-two simple strong subangular plications, four to six of which are more or less elevated towards the front of the dorsal valve into a mesial prominence, and three to five depressed on the ventral valve so as to form a shallow sinus, and produced in front into a distinct linguiform projection.

The plications on the front of this shell have but very faint traces of the longitudinal depressed lines so common in this type of *Rhynchonellæ*, though occasionally

remains of very fine closely arranged zigzag striæ are seen crossing them near the margins of the valves.

In some of its varieties, this species approaches the *R. nucleolata* (Plate XXXI, fig. 1 & 2), but differs conspicuously in being usually larger, and in its more angular outline and much stronger plications. The beaks are also more prominent in this species, and the dorsal valve is more extremely elevated near the front: there are also differences in the visceral impressions. These differences of character are constant through a very extensive series from the young to the old shells.

This species belongs to the type of *R. wilsoni*, and may be said to be one step farther removed from that species than *R. nucleolata*; or, in other words, bearing about the same relation to the latter species which that one does to *R. wilsoni*.

Fig. 1 *a* – *d*. Young individuals of this species.

Fig. 1 *e* – *z*. Illustrations of the varying forms of this species, from those of medium size to the largest and most gibbous forms that have been observed.

Fig. 2 *a*. A cast of the ventral valve of this species, showing the muscular impression smaller than in *R. nucleolata*, Plate XXXI, fig. 2 *x*.

Fig. 2 *b*. A cast of the dorsal valve of the same species.

Fig. 2 *c*. Interior of the ventral valve, which partially preserves the form of the muscular imprint.

Geological position and locality. Shaly limestone of the Lower Helderberg group, Albany county.

Rhynchonella vellicata (n. s.).

PLATE XXXIII. FIG. 1 *a* – *p*.

SHELL varying from transversely oval to subtriangular. Ventral valve depressed convex: beak somewhat prominent, depressed, closely incurved over the opposite. Dorsal valve more gibbous: beak incurved, not prominent.

SURFACE marked by twenty-four to thirty-six plications, six or eight of which are elevated in front of the dorsal valve so as to form a rather distinct mesial prominence, rarely extending beyond the middle of the valve. On the ventral valve, five to seven of the plications are depressed towards the front into a more or less distinctly defined sinus, and prolonged, forming a mesial projection which is elevated in the front of the other valve. Near the junction of the valves in front, very fine closely arranged lines of growth are visible.

This shell approaches very nearly, in some of its characters, the *Rhynchonella abrupta* : there are, indeed, some forms which it is difficult to distinguish. In the well-characterized specimens of this species, it differs from that one in its smaller and more numerous plications, and in being proportionally less ventricose, as well as in the narrower and deeper sinus of the ventral valve. The general aspect of the shells is quite distinctive.

Fig. 1 *a* – *e*. Dorsal, ventral, and profile views of characteristic specimens.

Fig. 1 *f*, *g*. A form more rotund than usual.

Fig. 1 *h*. An individual with a strongly marked sinus and much elevated mesial lobe.

Fig. 1 *i*. Profile view of a more gibbous form.

Fig. 1 *k*, *l*, *m*, *n*. More gibbous forms, which may probably be a variety of *R. abrupta*.

Fig. 1 *o*. Enlargement of the plications in front, showing the central impressed lines and arching striæ.

Fig. 1 *p*. Cast of the ventral valve, showing the lobed muscular impression.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Albany and Schoharie counties.

Rhynchonella altiplicata (n. s.).

PLATE XXXIII. FIG. 2 *a* – *k*.

SHELL subtrigonal, more or less gibbous. Ventral valve depressed convex : beak pointed, arched or nearly straight. Dorsal valve the larger, most elevated in the middle, declining with a curved outline towards the beak and margins : beak incurved ; foramen triangular, extending to the apex of the beak.

SURFACE marked by from ten to about nineteen simple, strongly elevated, sharply angular plications on each valve ; two to four of which are elevated on the dorsal valve into a more or less distinct mesial prominence extending nearly to the beak ; and from one to three depressed on the middle of the ventral valve into a distinct sinus, which widens regularly and somewhat rapidly from near the beak to the front, where it is prolonged into a short projection, filling a corresponding sinus in the front of the opposite valve : shell traversed by fine concentric lines of growth.

Along the lateral slopes of the cardinal margin, on each side of the beaks, there is generally an oval space of greater or less extent, not plicated : this, although

sometimes slightly concave, is never so distinctly impressed as it often is in species of the type of *R. wilsoni*.

Fig. 2 *a*, *b*. Dorsal views of two small individuals.

Fig. 2 *c*, *d*. Front views of the same.

Fig. 2 *e*. Profile of one of these.

Fig. 2 *f*, *g*. Dorsal and ventral views of a larger individual.

Fig. 2 *h*, *i*. Front and profile of the same.

Fig. 2 *k*. Enlargement of the surface, showing the angular plications and sharply arching striæ, which are more closely arranged than represented in the figure.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Albany and Schoharie counties.

Rhynchonella acutiplicata (n. s.).

PLATE XXXIII. FIG. 3 *a* – *e*.

SHELL subquadrangular, compressed. Ventral valve depressed convex, most prominent near the beak. Dorsal valve slightly larger than the ventral, most prominent in the middle, declining with a gentle curve towards the beak and margins : beak incurved.

SURFACE ornamented by about twenty-seven simple, moderately elevated, acutely angular or subcarinate plications on each valve, about five of which are elevated on the dorsal valve into a mesial prominence, which dies out before reaching the beak, and widens rapidly towards the front. On the ventral valve, four of the plications are depressed so as to form a broad rather shallow mesial sinus, with sloping sides, extending about two-thirds of the way to the beak. Shell marked by fine very regular subimbricating concentric lines of growth.

A distinguishing feature of this species is the sharply angular or subcarinate plications : in this character, however, it approaches the last described species; but its general form is much more compressed, proportionally more elongate, with more numerous and finer plications.

Fig. 3 *a*, *b*. Dorsal and ventral views of a specimen of this species.

Fig. 3 *c*, *d*. Profile and front views of the same.

Fig. 2 *e* (by mistake 3 *d*). Enlargement of the plications and concentric striæ.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Schoharie.

Rhynchonella? bialveata (n. s.).

PLATE XXXIV. FIG. 1 – 4.

SHELL small, triangular or triangular-ovate, sometimes compressed. Valves nearly equally convex : beak of dorsal valve incurved : beak of ventral valve almost straight and subangular; foramen narrow triangular, and continued to the apex of the beak.

SURFACE ornamented by from twelve to fourteen simple angular plications on each valve; the two central of which, on the dorsal valve, die out a little before reaching the beak, near which they are somewhat depressed, but towards the front they become slightly elevated above the others, so as to form an indistinct mesial prominence. The middle plication on the ventral valve is smaller than the others, and depressed near the front so as to produce a faint sinus, which extends about two-thirds of the way to the beak, at which point the valve is most convex. The two plications bordering the sinus are larger and more prominent than those on each side of them, and become obsolete before reaching the beak. A few faint imbricating lines of growth are visible near the junction of the valves in front.

Fig. 1 *a*, *b*. Dorsal and ventral views of a small individual.

Fig. 2 *a*, *b*, *c*. Dorsal, ventral, and profile views of a less elongate form.

Fig. 3 *a*, *b*, *c*. An individual having the plications nearly equal, and showing scarcely any indication of a sinus in front.

Fig. 4. An enlarged figure of the same species.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Albany county.

Rhynchonella inutilis (n. s.).

PLATE XXXIV. FIG. 7 & 8.

SHELL subtriangular or subglobose. Beak of ventral valve small, closely curved upon the opposite. Dorsal valve a little larger : beak incurved.

SURFACE ornamented by eighteen or nineteen simple sharply elevated plications, about four or five of which are elevated on the dorsal valve so as to form a more or less distinct mesial fold, which extends to about

the middle of the valve; while three or four of those on the middle of the ventral valve are depressed towards the front into a sinus, which is faint and broad in some specimens, and narrow and more distinctly defined in others. A few strong imbricating zigzag lines of growth near the margins of the valves.

This species is quite rare, and the individuals figured may be only the young, the mature forms having escaped observation.

Fig. 7 *a*, *b*. Ventral and profile views of a small individual.
Fig. 8 *a*, *b*. Ventral and front views of a more rotund form.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Albany county.

Rhynchonella transversa (n. s.).

PLATE XXXIV. FIG. 9 – 16.

SHELL subtriangular, wider than long, tapering abruptly to the beak. Ventral valve depressed convex, most prominent near the beak : beak arched. Dorsal valve a little larger, most elevated near the front : beak incurved; foramen narrow, continued up to the apex of the beak.

SURFACE ornamented by about fourteen or fifteen sharply elevated plications on each valve, of which from three to four are elevated near the front into a rather faint mesial fold, and two or three depressed on the ventral valve so as to form a faint sinus in the front. Somewhat strong zigzag lines of growth mark the surface of the valves near the margin in front.

Fig. 9 – 14 *a*, *b*, *c*. A series of individuals showing a regular gradation in size, with a gradually increasing depth of sinus.

Fig. 15 & 16 *a*, *b*, *c*. Individuals having a more strongly defined sinus and mesial lobe; a single individual having but two folds in the sinus.

There is usually associated with this species another which agrees very nearly with it in character, being wider and more depressed in form, and which, without a better series of specimens for examination, I am unwilling to regard as distinct from this one. See figs. 17 – 19, same plate.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains, Albany county.

Rhynchonella rudis (n. s.).

PLATE XXXIV. FIG. 20 & 21.

SHELL triangular, wider than long; lateral margins abruptly tapering to the beak. Ventral valve much depressed or flattened : beak scarcely incurved. Dorsal valve the larger, much elevated in front, declining towards the beak, which is slightly incurved.

SURFACE marked by about ten rather distant plications on each valve, three of which are elevated near the front of the dorsal valve into a prominent mesial fold, and three depressed in the front of the other valve.

The surface of this shell was doubtless marked by concentric striæ; but the only specimens I have seen are not sufficiently well preserved to retain them.

Fig. 20 *a*, *b*, *c*. Ventral, front and profile views.

Fig. 21 *a*, *b*. Profile and front view of a similar form, which varies in some respects.

Geological position and locality. Upper calcareous part of the shaly limestone of the Lower Helderberg group, Hudson.

Rhynchonella planoconvexa (n. s.).

PLATE XXXIV. FIG. 22.

SHELL subcircular or transversely oval. Ventral valve depressed convex, most prominent near the beak. Dorsal valve larger, regularly convex.

SURFACE marked by about twenty-four sharply elevated plications on each valve, several of which bifurcate towards the margin, and about six of which are very slightly elevated near the front of the dorsal valve, so as to form a broad flat indistinct mesial prominence, corresponding to a faint shallow sinus in the opposite valve.

A single imperfect specimen only of this species has come under my observation. The regularly arched dorsal valve (which is moderately elevated), the flattened mesial fold, depressed ventral valve, and bifurcating striæ will probably serve to distinguish it from all the allied forms found in our rocks.

Fig. 22. A cast of the dorsal valve, preserving the shell upon the margins.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Albany county.

Rhynchonella sulcoplicata (n. s.).

PLATE XXXV. FIG. 1 *a*, *b*, *c*.

SHELL subtriangular, wider than long, compressed. Valves nearly equal: beak of the ventral valve prominent, attenuated, acutely pointed and arched: beak of the dorsal valve incurved.

SURFACE marked by about sixteen simple longitudinally grooved plications, four of which are very faintly elevated towards the front of the dorsal valve, forming an indistinct mesial fold, corresponding to a sinus in the opposite valve which is occupied by three plications.

A marked peculiarity of this species is the longitudinal groove along the centre of each of the plications. Of the four plications elevated on the dorsal valve, the two central ones are less prominent than the others, and separated by a deeper and wider depression which continues quite to the apex of the beak.

Fig. 1 *a*, *b*. Ventral and front view.

Fig. 1 *c*. Enlargement of the striæ.

Geological position and locality. In the shaly limestone of the Lower Helderberg group: Albany county.

Rhynchonella formosa (n. s.).

PLATE XXXV. FIG. 6 *a* – *y*.

SHELL subtriangular or transversely oval; lateral margins forming an angle at the beak of about 90° to 110°. Ventral valve somewhat more depressed than the opposite: beak prominent, arched, not strongly incurved. Dorsal valve larger, declining with a gentle curve towards the margins: beak incurved.

SURFACE marked by twenty to twenty-four simple angular plications on each valve, from two to four of which in the middle are coarser and depressed in the ventral valve, having a corresponding number abruptly elevated upon the dorsal valve; concentrically marked by fine closely arranged striæ.

This handsome species may be recognized by the neatly rounded outline of the latero-basal margins, the abrupt sinus, and the stronger central plications.

A single specimen from the same position as the above shows a less distinctly defined sinus and mesial elevation, with five plications on the latter and four in the former, and only six on each side. I am disposed to regard this as only a variety of the above, though future collections may prove it to be distinct. Fig. 2 *a*, *b*, *c* and

d of the same plate are given to illustrate this form. Fig. 3 and 4 *a*, *b*, *c*, *d*, *e*, *f*, of the same plate, illustrate specimens with from two to four plications on the mesial elevation, and from four to six on each side. One specimen from the shaly limestone of Becraft's mountain shows a single sharp plication in the mesial sinus, and two elevated upon the opposite valve.

Fig. 6 *a* – *e*. Ventral, dorsal, profile, and front views of several individuals of the typical form, with strong plications.

Fig. 6 *f* – *l*. Specimens with finer and more numerous plications.

Fig. 6 *m* – *y*. Illustrations of specimens which present the ordinary variations of full-grown individuals, from the Upper Pentamerus limestone.

Geological position and locality. In the shaly limestone of the Lower Helderberg group, and in the Upper Pentamerus limestone : Helderberg mountains, Schoharie, Hudson, Catskill, Carlisle, Cherryvalley, and other places.

Rhynchonella eminens (n. s.).

PLATE XXXVII. FIG. 3 & 4.

SHELL abruptly ovoid or depressed subglobose. Dorsal valve the larger, elevated near the front into a flattened mesial prominence, from which it declines gently towards the beak and more abruptly towards the lateral margins, which are deflected towards the opposite valve : beak incurved. Ventral valve flattened, very abruptly deflected at the margins towards the opposite valve, having a broad well-defined sinus reaching from near the middle to the front, and prolonged into a linguiform extension.

SURFACE marked by about twenty-six rounded or scarcely subangular plications, about six of which are on the mesial fold and five in the opposite sinus; the whole crossed by fine undulating or zigzag lines of growth near the front of the valves.

Sometimes the plications bounding each side of the mesial fold in this species bifurcate; and one of them becomes obsolete before reaching the front, as in *R. abrupta* and *R. vellicata*. From both of these species, it may be distinguished by its more rounded plications and more prominent mesial fold, as well as in being a more robust shell.

Fig. 3 *a*, *b*. Dorsal, front, and profile views of an individual of medium size.

Fig. 4 *a*. Dorsal valve of a larger individual.
The species sometimes attains larger size than fig. 4.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains, Albany county.

Rhynchonella ventricosa (n. s.).

PLATE XLIII. FIG. 1 *a* – *m*.

SHELL varying from spheroidal to vertically ovoid, extremely ventricose; depth of the valves often nearly double their breadth : valves nearly equal in the young state. Dorsal valves sometimes a little depressed in the umbonial region : beak incurved; cardinal region on each side of the beak elevated. Ventral valve having a long linguiform extension : beak rather small and obtuse, closely incurved upon the opposite, subangular along its lateral slopes.

SURFACE marked by fourteen to twenty rounded plications, three or four of which are sometimes very slightly elevated on the middle of the dorsal valve, so as to form an extremely obscure mesial fold, and two or three as much depressed on the ventral valve : plications on the front marked with a longitudinal depressed line, and remains of much finer closely arranged zigzag lines of growth.

In the young shell the two valves are nearly equal; but as it grows older, the dorsal valve becomes more ventricose, attaining its maximum in fig. 1 *i*.

This species belongs to the type of *R. wilsoni*, and is one of those forms which are often referred to that species. In some of its varieties it resembles *R. pyramidata*; but that species is more angular on the sides, and never so abruptly sloping to the beaks. In some of its phases it more nearly resembles the *R. nucleolata* in form, but the plications are stronger.

Among many hundreds of individuals of the preceding species collected from the Shaly limestone, I have not seen one of this species, and it apears to be restricted to a bed in the upper part of the group.

Fig. 1 *a*, *b*, *c*. Dorsal, ventral, and profile views of a specimen of ordinary size and proportions.

Fig. 1 *d*. Front view of the same specimen.

Fig. 1 *e*, *f*, *g*, *h*. Dorsal, ventral, and profile views of more ventricose specimens.

Fig. 1 *i*, *k*. Profile and front views of an extremely ventricose specimen.

Fig. 1 *l*. Dorsal view of a more elongate form than usual.

Fig. 1 *m*. Enlargement of the plications, showing impressed lines and strong striæ in the front of the shell.

Geological position and locality. In the upper pentamerus limestone of the Lower Helderberg group : Schoharie, Carlisle and Cherryvalley.

Rhynchonella campbellana (n. s.).

PLATE XLIII. FIG. 2 *a* – *k*.

SHELL longitudinally oval, ovate or oblong, laterally compressed, two-thirds as broad as long, length and height about equal. Dorsal valve the larger, elevated near the front into a broad undefined mesial fold, declining near the beak and curving abruptly at the sides : beak incurved. Ventral valve compressed, abruptly deflected towards the opposite valve at the lateral margins, depressed into a broad rounded sinus which occupies almost the entire breadth of the narrow front : front margin curving upward, and extended into a subtriangular prolongation.

SURFACE marked by twenty-two to twenty-four simple rounded subangular plications, five or six of which are elevated on the mesial fold, and four or five occupy the sinus of the ventral valve. Fine zigzag lines of growth are seen on the front of the shell, near the junction of the valves.

This species bears much resemblance to the *R. nobilis* in many of its characters, but the depressed ventral valve and straight sides are pretty constant and distinguishing features. The casts of the two species show still more conspicuous differences, as may be seen in comparing figures 2 *f* and 3 *l*.

Fig. 2 *a* – *e*. Ventral, dorsal, and front views of young specimens.

Fig. 2 *f*, *h*. Dorsal and profile views of an individual of full size.

Fig. 2 *g*, *i*. Ventral and front views of an individual of full size, which is broader in the middle than usual.

Fig. 2 *k*. Enlargement of several plications of the front of the ventral valve.

Fig. 2 *f*. A cast of the ventral valve [the letter *f* should be *l*].

Geological position and locality. In the shaly limestone of the Lower Helderberg group, and in the succeeding "*Scutella limestone*" of the same group : Helderberg mountains, Albany county.

Rhynchonella nobilis (n. s.).

PLATE XLIII. FIG. 3 *a* – *l*.

SHELL varying from compressed ovate to subrhomboidal, becoming in adult specimens broad ovate and much more gibbous. Dorsal valve the larger, elevated in front into a somewhat rounded mesial prominence which rarely extends beyond the middle of the shell, declining laterally with an abrupt curve to meet the inflected edges of the opposite valve : beak incurved. Ventral valve depressed (in old specimens), abruptly inflected at the margins towards the opposite valve, depressed towards the front into a shallow rounded mesial sinus, sometimes prolonged into a vertical extension with nearly parallel sides : beak small, not prominent, incurved.

SURFACE marked by twenty-six to thirty-two strong angular plications, six to eight of which are elevated on the mesial fold of the dorsal valve, and five to seven depressed in the sinus of the other valve. Fine closely arranged zigzag lines of growth may be seen near the margins of the valves in front.

This species holds a position between *R. abrupta* and *R. campbellana* : it is, however, always more elongated than the first, and not so much so as the latter. It also resembles *Terebratula eucharis* of BARRANDE (Silur. Brach. aus Bœhmen, Pl. xvii, f. 2); but is more gibbous in old specimens, and more elevated in front, as well as more finely plicated.

Fig. 3 *a*, *b*. A young specimen with a scarcely defined sinus.

Fig. 3 *c*, *d*, *e*, *f*. Dorsal, ventral, front, and profile views of an individual of medium size.

Fig. 3 *g*, *h*. Dorsal and front views of a larger and more gibbous specimen.

Fig. 3 *i*, *k*. Dorsal and front views of the largest and most ventricose form that has been observed.

Fig. 3 *l* [by error marked 3 *b*]. A cast of the ventral valve of this species.

Geological position and locality. In the Upper Pentamerus limestone, Albany and Schoharie counties.

GENUS EATONIA (n. g.).

For description and illustration of this genus, see the same under Oriskany sandstone.

Eatonia medialis.

PLATE XXXVII. FIG. 1 *a* – *y*.

Atrypa medialis : VANUXEM, Geological Report of the Third District, 1843, pa. 121, f. 4.

SHELL transversely oval, suborbicular or subquadrate : hinge line nearly straight, and forming a very obtuse angle at the beaks. Dorsal valve much larger than the ventral, greatly elevated in the middle (especially near the front), declining with a gentle curve towards the hinge and very abruptly towards the sides. Ventral valve flat or concave, depressed in front so as to form a broad and profound mesial sinus : beak very small, pointed but not prominent, incurved, perforate at the extremity.

SURFACE marked by from twelve to sixteen broad rounded rarely bifurcating plications, four of which usually occupy the summit of the mesial fold of the ventral valve, and about three the bottom of the sinus in the dorsal valve : entire surface (in well-preserved specimens) marked by fine radiating striæ, and rarely by a few imbricating lines of growth. The muscular impression in the ventral valve moderately large, ovate, very distinctly defined by a prominent border, and marked by longitudinal slightly radiating plications : near its centre is the small cordiform longitudinally striate impression of the adductor muscle.

Associated with this species are a few forms, which, although differing materially from it, I am at present inclined to regard as merely extreme varieties of the same species. Some of these are given on the same plate (See fig. 1 *a* – *g*). In some instances (such as 1 *c*, *d*, *f* & *g*), the plications are almost entirely obsolete, and the valves are compressed together around the front and lateral margins.

The fine longitudinal striæ, as well as the finer concentric striæ, are rarely preserved upon the specimens which I have seen; though its occurrence upon a few perfect specimens prove this character to have originally existed. In the *Eatonia peculiaris* and *E. singularis*, the fine longitudinal striæ are characteristic of the

Eatonia peculiaris.

PLATE XXXVIII. FIG. 21 – 26; and PLATE CI. FIG. 2.

Atrypa peculiaris : CONRAD, Ann. Report on the Palæontology of New-York, 1841, p. 56.

SHELL longitudinally ovate, the proportion of length and breadth variable: cardinal margins sloping abruptly from the beaks. Ventral valve depressed convex in the middle towards the beak, and flattened towards the margins, which are abruptly inflected along the cardinal slopes; below the middle, extended in a broad not strongly defined mesial depression, which is prolonged in front into a linguiform extension: beak moderately elevated, perforate. Dorsal valve convex in the middle, and sloping abruptly to the lateral margins; the central part below the middle elevated into a rounded mesial fold, which becomes very prominent in front: margins of the valves denticulate.

SURFACE marked by fine radiating bifurcating striæ; a stronger elevated one along the centre of the mesial sinus, and a narrow longitudinal depression down the centre of the dorsal valve, the mesial elevation of which is sometimes obtusely subplicate near the margin.

This species was regarded by Mr. CONRAD as restricted to the Oriskany sandstone; but in the course of many years' collections, a considerable number of specimens have been found in the limestone of the Lower Helderberg group. In its surface characters, it scarcely differs from the preceding species: the form, however, is always more or less distinctly ovate, the mesial sinus less deeply and less distinctly pronounced; while the mesial fold of the opposite valve is less abrupt, and does not extend so nearly to the beak of the valve; the margins of the valves, and particularly of the ventral valve, are distinctly inflected along the cardinal slopes, giving an undefined oval area on each side below the beaks. The crenulations in front are always visible in well-preserved specimens, and these sometimes produce a slight undulation or plication of the exterior near the margins.

Fig. 21. Illustrations of one of the shorter forms of this species.

Fig. 22 *a*, *b*. Dorsal and profile views.

Fig. 23 *a*, *b*. Dorsal and front views of a full-grown specimen, showing the denticulations in front.

Fig. 24 *a*, *b*, *c*. Profile, ventral, and front views of a specimen which shows more distinctly the denticulations in front.

Fig. 25 *a*, *b*. Ventral and dorsal views of a cast of this species.

Fig. 26. Enlargement of the surface striæ.

Eatonia singularis.

PLATE XXXVIII. FIG. 14 – 20.

Atrypa singularis : VANUXEM, Geol. Report Third District New-York, 1843, pa. 120, f. 3.

SHELL wider than long, varying in form from ovate to transversely elliptical or rhomboidal : hinge line very slightly declining from the beaks. Ventral valve depressed convex in the middle towards the beak, and concave between the centre and the deflected margins; and below the middle, extended into a deep broad sinus, which is prolonged and turned upwards in front at right angles to the longitudinal direction of the shell : beak small, closely incurved. Dorsal valve convex, sometimes gibbous, and sloping abruptly to the margins; having a strong mesial fold beginning above the centre, and produced in a broad flattened and greatly elevated extension.

SURFACE marked by fine radiating striæ, which, in well-preserved specimens, are crossed by much finer concentric striæ : a single central one, and sometimes two or three of the striæ upon the mesial sinus, are much stronger than the others; and there is sometimes an impressed line down the centre of the dorsal valve.

The inner margins of the shell are denticulate, but this character is not shown in well-preserved specimens : it is seen in the casts, and upon the edges of the shell when worn from the exterior.

Fig. 14 – 16. Ventral, dorsal, and profile views of specimens of the ordinary size.
Fig. 17 *a*, *b*, *c*, *d*. Ventral, front, cardinal, and profile views of larger individuals.
Fig. 19 *a*, *b*. Ventral and dorsal views of a cast of this species.
Fig. 20. Enlargement of the surface striæ.

Geological position and locality. In the upper part of the shaly limestone of the Lower Helderberg group : Helderberg mountains, and Schoharie.

Eatonia peculiaris.

PLATE XXXVIII. FIG. 21 – 26; and PLATE CI. FIG. 2.

Atrypa peculiaris : CONRAD, Ann. Report on the Palæontology of New-York, 1841, p. 56.

SHELL longitudinally ovate, the proportion of length and breadth variable: cardinal margins sloping abruptly from the beaks. Ventral valve depressed convex in the middle towards the beak, and flattened towards the margins, which are abruptly inflected along the cardinal slopes; below the middle, extended in a broad not strongly defined mesial depression, which is prolonged in front into a linguiform extension: beak moderately elevated, perforate. Dorsal valve convex in the middle, and sloping abruptly to the lateral margins; the central part below the middle elevated into a rounded mesial fold, which becomes very prominent in front: margins of the valves denticulate.

SURFACE marked by fine radiating bifurcating striæ; a stronger elevated one along the centre of the mesial sinus, and a narrow longitudinal depression down the centre of the dorsal valve, the mesial elevation of which is sometimes obtusely subplicate near the margin.

This species was regarded by Mr. CONRAD as restricted to the Oriskany sandstone; but in the course of many years' collections, a considerable number of specimens have been found in the limestone of the Lower Helderberg group. In its surface characters, it scarcely differs from the preceding species: the form, however, is always more or less distinctly ovate, the mesial sinus less deeply and less distinctly pronounced; while the mesial fold of the opposite valve is less abrupt, and does not extend so nearly to the beak of the valve; the margins of the valves, and particularly of the ventral valve, are distinctly inflected along the cardinal slopes, giving an undefined oval area on each side below the beaks. The crenulations in front are always visible in well-preserved specimens, and these sometimes produce a slight undulation or plication of the exterior near the margins.

Fig. 21. Illustrations of one of the shorter forms of this species.

Fig. 22 *a*, *b*. Dorsal and profile views.

Fig. 23 *a*, *b*. Dorsal and front views of a full-grown specimen, showing the denticulations in front.

Fig. 24 *a*, *b*, *c*. Profile, ventral, and front views of a specimen which shows more distinctly the denticulations in front.

Fig. 25 *a*, *b*. Ventral and dorsal views of a cast of this species.

Fig. 26. Enlargement of the surface striæ.

PLATE CI.

Fig. 2 *a*, *b*, *c*. Dorsal, ventral, and profile views of a specimen presenting the ordinary form of this species in the Oriskany sandstone.

Fig. 2 *d*, *e*. Dorsal and ventral views of a cast of this species.

Fig. 2 *f*. A specimen preserving part of the shell and the vascular impressions near the margin.

Fig. 2 *g*. A cast of the ventral valve showing the muscular and vascular impressions.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Hudson; and in the Oriskany sandstone, Helderberg mountains; Schoharie; Cumberland, Maryland, and other places.

GENUS LEPTOCŒLIA (n. g.).

For description and illustration of this genus, see the same under Oriskany sandstone.

Leptocœlia concava.

PLATE XXXVIII. FIG. 1 – 7.

SHELL ovate or suborbicular. Ventral valve convex, elevated along the middle into a mesial prominence, which extends to the umbo : beak small, incurved beyond the hinge line. Dorsal valve flattened near the lateral margins, depressed in the middle, forming a shallow undefined sinus which is deeper in the centre than at the front, and rapidly diminishes towards the umbo : beak straight; area, or false area, small; foramen triangular and extending to the apex of the beak, sometimes closed below by a deltidium.

SURFACE marked by fourteen to seventeen striæ, which sometimes bifurcate : the one on the mesial fold is generally smaller than the others, giving a slightly grooved appearance along its centre quite to the beak.

The sinus in the dorsal valve of this shell widens so rapidly from the beak towards the front, and is so much deeper in the centre than near the beak and at the front of the shell, that it gives in some instances a marked concavity to this valve.

This species may be considered a representative of *Terebratula duboisi* of DE VERNEUIL (Géologie de la Russie, Pl. x, f. 16); from which it differs in its more rounded outline, and in the greater concavity of the dorsal valve.

Fig. 1 & 2 *a*, *b*, *c*. Dorsal, ventral, profile, and front views of this species.

Fig. 2. Enlargement of the beak of the dorsal valve, showing the foramen and false area.

Fig. 3 & 4. Specimens with a more extended hinge line, and which present some slight differences in the striæ.

Fig. 5 & 6. Interior of a small and a large ventral valve.
Fig. 7. The ventral valve enlarged.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains; Catskill, Hudson, Schoharie, and other places.

Leptocœlia imbricata.

PLATE XXXVIII. FIG. 8 – 13.

SHELL longitudinally semielliptical or suborbicular. Ventral valve convex, most prominent along the middle, and sloping laterally : beak small, incurved at the apex and perforated by a very small round aperture, one side of which is formed by the deltidium. Dorsal valve flattened or depressed convex : beak scarcely elevated above the hinge; hinge line sloping from the beaks at an angle of about 150°, rounded at the extremities, nearly equal to the greatest width of the shell; false area narrow, much shorter than the hinge.

SURFACE marked by ten to twelve plications on each valve, of which two on the middle of the ventral valve are larger and more elevated than the others, and separated by a wider and deeper depression than between those on each side. The central plication on the dorsal valve is larger than the others near the front, but usually dies out before reaching the beak. Shell marked by strong imbricating concentric lamellæ of growth.

This species resembles *Leptocœlia* (*Atrypa*) *disparilis* of the Niagara group, but is generally larger, has more plications and a straighter hinge : its dorsal valve also differs, in being slightly convex instead of concave. It also bears a general resemblance to *Terebratula lepida* (GOLDFUSS) and *T. sublepida* (DE VERNEUIL), but has a wider hinge than either of these, and differs likewise from them in other obvious and essential characters.

Fig. 8, 9 & 10. Illustrations of the dorsal and ventral valves of the ordinary forms of this species.
Fig. 11 & 12. Individuals differing somewhat in the plications from the more common forms.
Fig. 13. Dorsal view of a specimen enlarged.

The comparative extension of the hinge line in different individuals is subject to much variation.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains; Schoharie, and other places.

Merista lævis.

PLATE XXXIX. FIG. 3 & 4.

Atrypa lævis : VANUXEM, Geol. Report of Third District, 1843, pa. 120, f. 2.

SHELL ovate, thin, somewhat ventricose. Ventral valve the larger, most gibbous in the centre and umbonial region, having a shallow mesial sinus extending from the front more than half way to the umbo : beak prominent, ventricose, incurved, not perforate. Dorsal valve regularly convex, gibbous in the middle, but without a defined mesial fold : beak incurved.

SURFACE smooth, or marked by obscure concentric lines and occasional stronger concentric wrinkles of growth, and, in the exfoliated shell, by obscure radiating striæ.

Some varieties of this species, especially the adult shell, often resemble *Merista bella*, but differ in being proportionally longer, and are never marked by a sinus on the dorsal valve. Young shells are sometimes comparatively much more compressed, and often destitute of any trace of a sinus on either valve.

This species presents considerable variety in form and proportions; but after comparing extensive collections, I am compelled to unite all the varieties represented by figures 3 *a* – *s* as this species. There are numerous intermediate forms, some of which have relations to those on the following plate; but the latter are generally constant in the characters exhibited.

The species was founded by Mr. VANUXEM upon specimens from the compact portion of the shaly limestone of Herkimer county, which usually have a more gibbous form than those of the Helderberg mountains.

Fig. 3 *a*, *b*, *c*, *d*, *e*. Dorsal, ventral, profile, and front views of young individuals.

Fig. 3 *f*, *g*, *h*, *i*, *k*. Dorsal, profile, and front views of larger specimens. The specimen fig. 3 *g* presents no emargination in front, as do the specimens 3 *f* – *k*.

Fig. 3 *l*, *m*, *n*. Front, dorsal, and cardinal views of a full-grown individual.

Fig. 3 *o*, *p*, *r*, *s*. Dorsal, profile, and ventral views of a larger specimen, showing a stronger emargination in front, and a mesial sinus extending nearly to the beak of the ventral valve.

Fig. 3 *t*, *u*. Dorsal and profile views of a larger individual, which has no sinus or elevation upon the valves. (It is possible that this may prove a distinct species).

Fig. 4 *a*. Interior of the ventral valve.

Fig. 4 *b*, *c*, *d*. Casts of the ventral valve, and profile of the same.

The specimens figured on Plate XXXIX, fig. 1 & 2, present some variations from the prevailing characters of *M. lævis;* but I have not had an opportunity of seeing

sufficiently extensive collections to determine fully these characters, or whether it may be only another phase of that species in its young state.

Geological position and locality. In the shaly and compact limestones of the Lower Helderberg group : Albany, Schoharie and Herkimer counties.

Merista bella (n. s.).

PLATE XL. FIG. 1 *a* – *p*.

SHELL varying from suborbicular or subquadrilateral to transversely oval, usually somewhat broader than long, gibbous. Ventral valve a little the larger, most convex near the umbo : beak prominent and closely incurved. Dorsal valve convex, gibbous in the middle and towards the umbo : both valves marked with a small sublinear mesial sinus, that of the ventral valve stronger than the other, the two often giving a distinct emarginate outline to the front.

SURFACE smooth, or marked by faint concentric lines of growth, with much fainter indications of radiating striæ.

This species is characterized by its symmetrical form and the distinctly emarginate character of the front, caused by the meeting of the narrow mesial depressions of the two valves. The sinus on the front of the ventral valve is always broader and deeper than that on the other, giving a waved outline to the margins of the valves. Some of the specimens appear to have a small open foramen in the point of the beak, but which may be accidental.

It is closely related to *Terebratula compressa* (MURCHISON), but attains a larger size than any of that species figured, and is almost always more gibbous, especially the ventral valve near the beak.

A single specimen, perhaps of this species (Plate XL, fig. 2 *c*, *d*, *e* & *f*), is much more compressed than the others, and less distinctly sinuate on the middle of the valves, and consequently nearly destitute of the emargination in the front. I have regarded this one as a distinct species; but as no other specimens have come under my observation, I am inclined to consider it for the present as a variety of the *M. bella*.

Fig. 1 *a* – *h*. Dorsal, ventral, profile, front, and cardinal views of young shells.

Fig. 1 *i*, *k*, *l*. Views of a larger specimen. The species rarely attains a larger size than these figures.

Fig. 1 *m* – *p*. Views of an unusually large specimen of this species.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains; Schoharie, Carlisle, and other places.

Merista subquadrata (n. s.).

PLATE XL. FIG. 3 *a* – *d*.

SHELL subquadrate. Ventral valve the larger, gibbous in the middle and umbonial region : beak prominent, incurved, apparently perforate. Dorsal valve depressed convex : front slightly elevated, forming a small undefined mesial prominence immediately on the margin : beak well defined, incurved.

SURFACE smooth, or marked with many indistinct concentric lines of growth.

The most marked characters of this species are its obliquely subquadrate form, and the slight elevation of the front margin of the dorsal valve, without any trace of a corresponding sinus in the opposite valve.

Two well-marked specimens of this species only have been observed; but the form and general characteristics are so well exhibited in both, that there is little difficulty in identifying it among the more common forms of the genus.

Fig. 3 *a*. Dorsal view of this species.

Fig. 3 *b*. Ventral view, showing the marks of the internal spires.

Fig. 3 *c*, *d*. Profile and front view of the same.

Geological position and locality. In the shaly limestone and in the lower pentamerus limestone of the Lower Helderberg group : Schoharie and Carlisle.

Merista arcuata (n. s.).

PLATE XLI. FIG. 1 *a* – *t*.

SHELL broad ovate, sometimes transversely oval. Ventral valve longitudinally arcuate, gibbous in the central and umbonial region, having in front a shallow rounded depression which scarcely reaches the middle of the valve : front margin (in old specimens) elevated, and filling the broad rounded sinus of the opposite valve. Dorsal valve often abruptly elevated and very gibbous along the middle, and sloping laterally, having no distinct mesial fold : beak incurved.

SURFACE smooth, or marked by faint concentric lines and occasional stronger wrinkles of growth, with faint radiating striæ which are more distinguishable upon the partially exfoliated shell.

Some varieties of this species bear considerable resemblance to *M. lævis;* but they are always proportionally broader, the hinge line declining less rapidly; the umbo of the ventral valve is less gibbous, while it is more regularly arcuate and broadly sinuate in front. The dorsal valve is very gibbous along the centre, sometimes forming an indistinct ridge, while the sides slope more abruptly to the margins which are often compressed.

Fig. 1 *a*, *b*. Dorsal and cardinal views of a young specimen.

Fig. 1 *c*, *d*, *e*, *f*. Dorsal, ventral and profile views of large specimens.

Fig. 1 *g*, *h*, *i*, *k*, *l*. Dorsal, ventral, profile and front views of full-grown individuals, showing the forms of well-preserved specimens.

Fig. 1 *m*, *n*. Dorsal and profile views of a very gibbous form, which is unusually extended laterally.

Fig. 1 *o*. Interior of a ventral valve.

Fig. 1 *p*. Cast of the beak of the ventral valve.

Fig. 1 *t*. An imperfect specimen which has been eroded at the sides, showing the internal spires.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains; Schoharie, Carlisle, Catskill, Hudson, and other places.

CASTS OF MERISTA : PROBABLY OF M. ARCUATA.

PLATE XLI. FIG. 2 *a* – *g*.

Fig. 2 *a*. Cast of the dorsal valve.

Fig. 2 *b*. Cast of the ventral valve, showing the muscular impressions and extended process which filled the beak of the shell.

Fig. 2 *c*, *d*. Casts of the ventral valve, showing some differences in the form of the muscular impressions, and the portion filling the cavity of the beak. The radiating striæ are partially preserved on fig. 2 *c*.

Fig. 2 *e*. Cardinal view of a well-preserved cast.

Fig. 2 *f*, *g*. Profile views of 2 *d* and 2 *c* respectively; the specimens 2 *c*, *g*, preserving the cast of both valves, 2 *d*, *f* being the ventral valve only.

These specimens are usually much compressed, and a large proportion of those found are distorted. The figures illustrate very satisfactorily the characters of the interior; and the marked difference between these and the casts of *Athyris* or *Spirigera*, as occurring in our strata, is very conclusive of the generic importance of MERISTA.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Becraft's mountain, Hudson.

Merista princeps (n. s.).

PLATE XLIV. FIG. 1 – 5.

SHELL ovate : sides sloping towards the beaks at an angle of about 60°. Ventral valve more or less profoundly arcuate longitudinally, most ventricose near the central and umbonial region, depressed below and having a broad shallow flat or subangular mesial sinus in front, terminating (in old specimens) in a linguiform extension which is bent upwards at right angles to the longitudinal plane of the shell : beak strongly incurved. Dorsal valve gibbous and extremely elevated along the middle, which becomes in front a strong rounded mesial elevation; sides of the valve declining very abruptly to the baso-lateral margins : beak closely incurved beneath that of the opposite valve.

SURFACE marked by obscure fine radiating striæ, which are crossed by indistinct concentric lines of growth; the latter often becoming conspicuous towards the margins.

This large and fine species differs considerably in the form and depth of the mesial sinus, as well as in the greater or less extension of the mesial prolongation of the anterior border of the ventral valve. In some of the specimens the sinus is very shallow and flattened within, while in other instances it is more impressed and angular in the middle : other specimens present intermediate grades of difference in this respect, the sinus being nearly flat within, and marked by a narrow, nearly linear, deeper depression along its middle. Young individuals are almost entirely destitute of a sinus, though the front of the dorsal valve in such cases is usually slightly elevated.

This is not a common species ; and it is probable that a larger collection of specimens would show some gradations of form and exterior characters, which would unite more intimately what now appear extreme varieties.

Fig. 1 *a*, *b* ; 2 *a*, *b*, & 3 *a*, *b*, *c*. Ventral, dorsal, profile and front views of young individuals, where the sinus is scarcely defined beyond the front, and there is no mesial fold on the dorsal valve.

These specimens preserve so much the character of *Merista lævis*, that I have some hesitation in placing them under this species; but they are more extended in front, and the outline less regularly curved.

Fig. 4 *a*, *b*, *c*, *d*. Dorsal, ventral, profile and front views, in which the characteristic features of the species are fully developed.

Fig. 4 *e*, *f*, *g*, *h*. Views of a specimen of extremely large size, showing the broad and shallow mesial sinus, and the linguiform extension in front, which is bent abruptly upwards.

Fig. 5 *a*, *b*, *c*, *d*. Views of a specimen having the form of the two preceding, but with a more narrow and angular sinus.

Geological position and locality. In the Upper Pentamerus limestone, and, rarely, in the Shaly limestone of the Lower Helderberg group : Helderberg mountains; Schoharie, and Carlisle.

Merista meeki (n. s.).

PLATE XLIV. FIG. 6 *a* – *d*.

SHELL cordate ovate, very gibbous, sloping from below the middle towards the beaks at an angle of about 80°. Ventral valve profoundly arcuate from the beak to the anterior margin, where it terminates in a prominent abruptly tapering mesial prolongation, having a broad angular sinus extending from near the beak to the base of the shell : beak flattened on the outside, subangular on its lateral slopes, closely incurved upon that of the opposite valve. Dorsal valve elevated along the middle, sloping laterally with an abrupt curve, very gibbous in the umbonial region : beak incurved.

SURFACE smooth, or marked by faint concentric lines of growth.

The shorter and more globose form of this species, as well as the deep angular sinus and flattened umbo of its ventral valve, are sufficient to distinguish it from all the preceding species.

Fig. 6 *a*, *b*. Ventral and dorsal views of this species.

Fig. 6 *c*, *d*. Profile and front views of the same.

Geological position and locality. In limestone of the age of the Lower Helderberg group : Tennessee.

Merista (species undetermined).

PLATE XLV. FIG. 1 *a*, *b*, *c*, *d*.

This species, of the size of fig. 1 *a* and more rarely of figs. 1 *b*, *c*, occurs in considerable numbers in the Upper Pentamerus limestone. Fig. 1 *d* has the same form and proportions; but I have been unable to obtain such a series of specimens as would enable me to determine fully its relations to the other species described, or whether it may be the extreme young of *M. princeps*.

Merista bisulcata.

Atrypa bisulcata : VANUXEM, Geol. Report of the Third District New-York, 1843, p. 112.

SHELL ovoid or elliptical, gibbous or subventricose. Ventral valve most gibbous towards the umbo, marked by a narrow mesial sinus which extends from the beak to the base of the shell, very gradually enlarging below : beak prominent, incurved. Dorsal valve very gibbous above, marked by a narrow depression from near the beak to the base ; beak short and closely incurved.

SURFACE marked by fine concentric lines and stronger wrinkles of growth, and, under a lens, by fine longitudinal striæ : substance of the shell apparently punctate.

I place this species under the Genus MERISTA with some hesitation, on account of the apparently punctate character of the shell, while the form and general aspect is similar to others of the genus.

Atrypa reticularis.

PLATE XLII. FIG. 1 *a* – *r*.

For synonyms, references, etc., see Palæontology of New-York, Vol. ii, p. 72.

The figures represent the variety of form which occurs in the rocks of this group. Although there are perhaps no technical differences between this one and those of the Clinton and Niagara groups, it yet assumes a greater variety of form, ranging from subglobose to ovoid as in figures 1 *a* – *k*, and the dorsal valve becomes extremely ventricose.

In the Upper Pentamerus limestone this shell is more finely striated, as in fig. 1 *f*, and more nearly circular in outline than those of the Shaly limestone below.

The muscular area is proportionally larger in the specimens from this rock than in those from the Niagara group, as may be seen on comparison of figs. 1 *n* & 1 *o* below with fig. 5 *s*, Plate LV of Vol. ii.

Fig. 1 *a*, *b*, *c*, *d*. Ventral and front views of young specimens.

Fig. 1 *f*, *g*, *h*. Dorsal, front and profile views, showing the ordinary size and proportion of the larger individuals.

Fig. 1 *e*. An individual of full size.

Fig. 1 *i*, *k*, *l*. Dorsal, ventral and profile views of an elongate or ovoid form of this species.

Fig. 1 *m*. Interior of the dorsal valve.

Fig. 1 *n*. Interior of the ventral valve, showing the teeth, muscular area, and the vascular impressions.

Fig. 1 *o*. The ventral valve of a smaller individual.

Fig. 1 *p*. A specimen with the dorsal valve partially broken away, showing the internal spires, which, by mistake of the lithographer, are represented as one.

Fig. 1 *r*. Front view, showing the arrangement of the spires.

Geological position and locality. In the Lower Pentamerus limestone, in the Shaly limestone very abundant, and in the Upper Pentamerus limestone of the Lower Helderberg group : Helderberg mountains, Schoharie, Carlisle, Hudson, Catskill, etc.; Pennsylvania; Virginia; Maryland.

Genus Rensselæria.

For description and illustration of this genus, see the same under Oriskany sandstone.

Rensselæria mutabilis (n. s.).

Plate XLV. Fig. 2 *a* – *p*.

Shell ovate varying to elliptic and obovate, not sinuate on either valve: old specimens sometimes very gibbous, but generally compressed towards the anterior border in young individuals : valves nearly equally convex. Ventral valve most elevated near the middle and towards the umbo : beak pointed, subangular along the lateral slopes, arched or closely incurved; foramen narrow, and extending nearly or quite to the apex of the beak. Dorsal valve slightly less elevated and a little shorter than the opposite : beak not projecting, incurved.

Surface marked by twelve to twenty-eight coarse obscure radiating striæ, crossed by fine indistinct lines of growth, and sometimes near the border by a few strong concentric undulations : the radiating striæ are usually obsolete on the upper half of the shell.

This species varies considerably in form, as well as in other characters. Young individuals are generally more compressed near the front, and the beak is more nearly straight; while older specimens are often quite gibbous, and sometimes marked by very strong concentric undulations : in the latter case, the beak of the ventral valve is generally closely incurved.

Fig. 2 *a*, *b*. Dorsal and profile views of a young specimen, the beak of which is straight.

Fig. 2 *c*. Dorsal view of a large specimen, where the beak is scarcely incurved.

Fig. 2 *d*, *e*, *f*, *g*. Specimens presenting the ordinary characters of the species.

Fig. 2 *h*. *i*. Dorsal and profile views of a more elongated form, which is slightly wider towards the upper part of the shell.

Fig. 2 *k*, *l*, *m*. Dorsal, profile and front views of a very gibbous specimen.

Fig. 2 *n*, *o*, *p*. Views of specimens which are much broader towards the upper part of the shell, very gibbous, and having the beak closely incurved.

Geological position and locality. In the higher part of the Shaly limestone, and more compact beds just beneath the Upper Pentamerus limestone of the Lower Helderberg group : Albany and Columbia counties.

Rensselæria æquiradiata.

PLATE XLV. FIG. 3 *a* – *g*.

Atrypa æquiradiata : CONRAD, Jour. Acad. Nat. Sci. Philadelphia, Vol. viii, pa. 266, pl. 16, f. 17.

SHELL elliptical or subovoid : valves nearly equal; without mesial fold or sinus. Ventral valve usually the more convex, gibbous, and often subangular along the centre of the upper part of the shell : beak much extended above the opposite, and incurved. Dorsal valve usually less convex than the opposite, and sometimes depressed convex : beak incurved beneath that of the opposite valve.

SURFACE marked by simple regular radiating striæ, which are much more conspicuous towards the margin of the shell.

The *R. mutabilis* resembles this species in its form and striæ; but among a large number of specimens examined, none have been observed larger than those figured.

Fig. 3 *a*, *b*, *c*. Dorsal, ventral and profile views of a larger specimen, which is proportionally longer than the prevailing forms.

Fig. 3 *d*. Front view of the same.

Fig. 3 *e*, *f*, *g*. Dorsal, ventral and front views of a larger specimen, which has a proportionally greater breadth than the preceding, resembling in this respect the figure of Mr. CONRAD cited above.

Geological position and locality. In the Upper Pentamerus limestone of the Lower Helderberg group : Schoharie, Carlisle, Cherryvalley.

Rensselæria elliptica (n. s.).

PLATE XLV. FIG. 4 *a*, *b*, *c*.

SHELL elliptical, gibbous or subventricose : valves nearly equally convex; front rather abruptly rounded; no trace of a sinus on either valve. Ventral valve arching from the middle towards the lateral margins, and forming longitudinally a semielliptic curve : beak gibbous, closely incurved and extended over that of the other valve. Dorsal valve most elevated near the middle, rounding laterally, and having a semielliptical outline from the front to the beak, which is incurved.

SURFACE marked by fine indistinct radiating striæ, which are crossed by obscure concentric lines and faint undulations of growth.

Fig. 4 *a*, *b*, *c*. Dorsal, profile and front views of the same specimen.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Schoharie county.

Rensselæria lævis (n. s.).

PLATE XL. FIG. 2 *a*, *b*.

SHELL broad oval or subquadrate, not sinuate. Ventral valve the more convex, most prominent along the middle and towards the beak, which is pointed and arched, rising above the hinge-line, but not closely incurved; foramen narrow, extending quite to the apex of the beak. Dorsal valve flat or depressed convex.

SURFACE smooth, or only marked by very obscure lines of growth.

The plano-convex form and smooth surface of this species will at once distinguish it from all its known congeners in the rocks of this State. It is possible there may be very fine obscure radiating striæ on perfectly preserved specimens of this species, though the only individual I have yet seen appears to have been smooth.

Fig. 2 *a*, *b*. Dorsal and profile views of a specimen of this species.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Albany county.

Pentamerus galeatus.

PLATE XLVI. FIG. 1 *a* – *z*; and PLATE XLVII. FIG. 1 *a* – *m*.

SHELL varying from ovoid to subglobose and transversely elliptical. Ventral valve gibbous, becoming in old shells very ventricose in the umbonial region; a strong mesial fold along the centre of the lower half of the valve: beak ventricose, arched, and strongly incurved over that of the opposite valve. Dorsal valve often nearly circular or transversely elliptical, gibbous above; area with or without a defined mesial sinus towards the lower margin: beak incurved, and filling the triangular foramen beneath the beak of the ventral valve.

SURFACE, in extremely young shells, smooth, or marked only by concentric lines of growth; in older forms, having longitudinal plications more or less developed, or rarely with none. Old shells variously plicated; the plications simple or bifurcating, and crossed by fine concentric striæ of growth, which sometimes become stronger imbricating laminæ towards the margin of the shell.

Internally the dental lamellæ are developed into a long spoon-shaped cavity or chamber, which forms a continuation from the triangular foramen or pit beneath the beak of the ventral valve. A central septum extends from the beak of the ventral valve, half the length of the shell, and, in its upper part, is united to the conjoined dental lamellæ or V-shaped chamber of this valve. In the dorsal valve the two septa extending from either side of the beak are attached to the shell for about half the distance to the base, below which point they become free.

This widely distributed species is characteristic of the compact limestones at the base of the Lower Helderberg group, and is known to occur in the same position as far south as Tennessee.

It presents a great variety of form and surface markings. In New-York, the extremely young specimens are always smooth, so far as I have observed. In the various stages of growth, they exhibit every possible degree of development in the plications; some individuals of nearly full size remaining smooth, while others are

strongly plicated before reaching half the full size; and some have plications only on the mesial fold and sinus. The plications sometimes bifurcate, as shown in a single individual on Plate XLVI and another on Plate XLVII.

Some specimens lately examined are much more finely and numerously plicated than any of those figured : I can regard them, however, only as varieties of the same species.

PLATE XLVI.

The illustrations upon this Plate show a few of the varieties of form and marking to which this species is subject.

Fig. 1 *a*, *b*, *c*. Young shells which are free from plications.

Fig. 1 *d*, *e*, *f*. A young specimen which has become very gibbous, and with plications strongly developed upon the mesial fold.

Fig. 1 *g*, *h*, *i*. Three specimens of half-grown individuals, showing the different degrees of development in the plications.

Fig. 1 *k*, *l*. A large specimen, in which no plications are developed. The surface presents well-marked concentric striæ, and obscure longitudinal striæ on the ventral valve.

Fig, 1 *m*. A dorsal valve which is strongly plicate, but shows no mesial sinus.

Fig. 1 *n*, *o*. Specimens showing the plications developed upon the mesial portion of the shell in very different degrees of strength.

Fig. 1 *p*. Profile of the specimen 1 *o*.

Fig. 1 *q*, *r*, *s*. Dorsal, profile and front views of a specimen having plications only on the mesial fold and sinus.

Fig. 1 *t*, *u*. Dorsal views of specimens with plications developed over the entire surface of the valves, the one with and the other without a mesial sinus.

Fig. 1 *w*. An individual showing bifurcating and coalescing striæ.

Fig. 1 *x*. Profile of the specimen 1 *w*.

Fig. 1 *y*, *z*. Front views of specimens, the one with and the other without a mesial sinus.

PLATE XLVII.

Fig. 1 *a*. A specimen having the beak of the dorsal valve broken off, showing the triangular cavity beneath the beak of the opposite valve.

Fig. 1 *b*, *c*. Ventral valves of this fossil : the one filled with stone, showing only the triangular cavity A ; and the other having the stone removed by weathering, showing the cavity A and the septum B, presenting the common character of this fossil as seen upon the weathered surface of the Lower Pentamerus limestone of the Lower Helderberg group.

Fig. 1 *d*. Dorsal valve, showing the entire extent of the cavity formed by the dental lamellæ, and the central septum below.

Fig. 1 *e*. Lateral view where portions of both valves are removed, showing the extent of the dental lamellæ or spoon-shaped cavity A as shown in fig. 1 *d*, the central septum of the ventral valve B, and one of the septa D of the dorsal valve, which becomes free at its extremity.

Fig. 1 *f*. Interior of the hinge ; E, E, the line of junction of the two valves. The septa of the upper or dorsal valve correspond to the extension of the dental lamella or sides of the spoon-shaped cavity in the lower or ventral valve.

Fig. 1 *g*. Dorsal view of a cast, showing the septa D, D ; the cast of the triangular cavity beneath the beak of the ventral valve A.

Fig. 1 *h*. Cardinal view of the same, showing the form of the cast filling the triangular cavity beneath the beak A, and its extension below into the central septum, which in the cast divides the valve into two parts. The lines of the two longitudinal septa of the dorsal valve are marked D, D, as in the preceding figure.

Fig. 1 *i*. Cast of the ventral valve, showing the longitudinal septum B*.

Fig. 1 *k*, *l*, *m*. Profile, ventral and front views of an extravagant specimen, which shows bifurcating plications upon the mesial sinus and fold.

Geological position and locality. This species is the characteristic one of the Lower Pentamerus limestone of the Lower Helderberg group, and large masses of the rock are often made up of the broken and separated valves of this fossil. The more perfect specimens are obtained from the Shaly limestone above the Pentamerus limestone : Helderberg mountains ; Schoharie, Carlisle, Cherryvalley ; Herkimer county ; Catskill, Hudson, and numerous other places in New-York ; Cumberland, in Maryland ; Decatur county, in Tennessee, and at numerous intermediate points.

Pentamerus pseudogaleatus.

PLATE XLVI, FIG. 2 *a* – *l*.

SHELL longitudinally ovate. Ventral valve extremely convex or ventricose, especially in the umbonial region : beak very prominent and strongly gibbous, incurved, and projecting far beyond that of the other valve; front margin, in adult shells, sometimes having a faint mesial prominence. Dorsal valve oval or subcircular, much shorter and more compressed than the opposite : beak incurved; front obliquely flattened, or very slightly depressed so as to form sometimes an indistinct sinus, often a little produced into a short truncate or rounded extension.

SURFACE smooth, or marked by faint concentric lines, and towards the margin by stronger wrinkles of growth.

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* These letters do not correspond with those used by DAVIDSON in his Introduction to the Classification of the Brachiopoda to indicate similar parts of the shell, simply because this plate, and most of the others of the same family, were engraved previous to the reception of Mr. DAVIDSON's work, and the letters were used merely for convenience of reference.

Young specimens of this species might be mistaken for the young of *P. galeatus*, which are, like this, destitute of plications. Its form, however, is much more elongated, and the beak more extended.

Fig. 2 *a*, *b*, *c*, *d*. Dorsal, profile and front views of young individuals.

Fig. 2 *e*. Dorsal view of a specimen of medium size.

Fig. 2 *f*, *g*. Front and profile views of the same specimen.

Fig. 2 *h*, *i*. Profile and front views of a very gibbous specimen, which represents the character of the ordinary full-grown individual.

Fig. 2 *k*, *l*. Dorsal and profile views of an unusually large specimen from which the shell is partially exfoliated, showing the two septa of the dorsal valve.

Geological position and locality. In the Upper Pentamerus limestone of the Lower Helderberg group; being the fossil which characterizes the higher compact beds of the group, as *P. galeatus* does those of the lower beds of the same : Helderberg mountains, Schoharie, Carlisle and other places.

Pentamerus verneuili.

PLATE XLVIII. FIG. 1 *a* – *y*.

SHELL subglobose; transverse diameter generally greater than the height. Ventral valve nearly circular or transversely elliptical, more depressed than the opposite, having a distinct sinus, commencing near the beak and regularly widening and deepening to the front, where it terminates in a short truncated extension fitting into a corresponding depression in the front of the other valve : beak shorter than the opposite, perforated by a triangular or subcircular foramen, which is generally covered by the strongly gibbous incurved beak of the other valve. Dorsal valve very much elevated : beak extremely gibbous or ventricose, and strongly incurved.

SURFACE marked by from twenty-four to thirty sharply angular elevated plications, which increase by interstitial addition and bifurcation : from four to six of the plications on the ventral valve usually occupy the sinus; while from five to eight of those on the dorsal valve are very slightly elevated, so as to form a flat rather indistinct mesial fold.

This species presents very marked differences from the other species of the genus known in our strata. The larger valve is the dorsal, and bears the two internal septa; while the smaller valve, or that with the sinus, is the ventral valve, having the triangular cavity beneath the beak, with a perforation at the extremity, and the dental lamellæ are produced into the elongated cavity represented in fig. 1 *u*, *x*; and which, from the thickening of the valve, is often affixed to the shell at its base without the intervention of the usual septum, which, when present, is a very subordinate feature. The dental lamellæ are lobed on the outside as shown in the figures above cited, leaving a space for the interlocking of the septa or brachial lamellæ of the opposite valve. The dorsal valve is marked by two converging septa, which extend scarcely more than one-third of the length of the shell, and terminate in a thickened ridge in the deepest part of the valve. From these laminæ or septa, near their junction with the hinge line, originate two broad thin brachial plates, which are very imperfectly shown in fig. 1 *t*.

This beautiful species, in the reversed character of the valves, resembles one from the Island of Anticosti, named by Mr. Billings *P. reversus;* but the latter is much more coarsely plicated, and without the interstitial plications. The species now described bears a very close resemblance to *Pentamerus* (*Atrypa*) *interplicata* of the Niagara group; which, although its internal structure has not been ascertained, I have no doubt is a true *Pentamerus*. The *P. verneuili*, however, is readily distinguished from that one by its larger size, more globose form, and more numerous plications.

In the young shells of this species, the dorsal valve is abruptly incurved; the beak of the ventral valve is nearly as high as the opposite, and has beneath it a distinct triangular foramen and an apparent area, which gives the cardinal line the appearance of that of an *Orthis*. As the shell grows older, the beak of the opposite valve fills the foramen; and the notch in the beak is carried farther inwards as the shell thickens, so that in old shells the beak presents a somewhat circular perforation, which communicates below with the triangular cavity.

In extremely young shells, there is no appearance of mesial sinus or elevation.

Fig. 1 *a*, *b*. Ventral and front views of a young specimen.

Fig. 1 *c*, *d*. Dorsal and profile views of a specimen larger than the preceding.

Fig. 1 *e*. The cardinal view of fig. 1 *c*, *d* enlarged, showing the triangular foramen and apparent area.

Fig. 1 *f*. Dorsal valve of a finely plicated specimen.

Fig. 1 *h*. The same enlarged, to show the regularly intercalated smaller plications.

Fig. 1 *g*. Ventral view, showing the bifurcating plications.

Fig. 1 *i*, *k*, *l*. Ventral, dorsal and profile views of a specimen with simple coarse plications.

Fig. 1 *m*. Front view of a specimen similar to the preceding.

Fig. 1 *n*, *o*, *p*. Ventral, profile and front views of a large specimen which preserves the prevailing character of the species. The profile view shows the incurved dorsal beak, and the nearly straight ventral beak, a little separated.

Fig. 1 *r*. Cardinal view, showing the short accessory plications which mark the lateral areas.

Fig. 1 *s*. Profile view of another specimen, showing the beaks of the two valves in contact, the usual condition of the shell.

Fig. 1 *t*. Interior of the dorsal valve, showing the two longitudinal septa and the broad brachial processes at the hinge line.

Fig. 1 *u*. Interior of the ventral valve, showing the elongate spoonshaped cavity, with the lateral lobes and the slight extension of the central septum.

Fig. 1 *x*. The same enlarged, showing the muscular imprints at the base of the cavity.

Fig. 1 *v*. Interior of the two valves in connexion, showing the triangular cavity and central septum below, and the double septa above with the lamellæ, which extend far into the interior of the upper or dorsal valve.

Fig. 1 *y*. Longitudinal section of the ventral valve, showing the comparative extent of the spoonshaped cavity and the narrow short septum below.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains; Schoharie, Carlisle, and other places.

Pentamerus littoni (n. s.).

SHELL ovoid, somewhat elongate. Dorsal valve moderately and regularly convex from base to umbo; beak almost rectangularly incurved beneath the beak of the opposite valve. Ventral valve very gibbous; beak subattenuate, incurved.

SURFACE marked by about eighteen or twenty simple subangular plications. There is a broad concave smooth space on each side below the beak of the ventral valve, and a much narrower space on each side of the dorsal valve.

In a specimen which is entire with the exception of the beak of the ventral valve, the greatest depth of the two valves together, which is about the middle of the shell, is equal to the greatest width, which is at a point much nearer the base.

I am indebted to Dr. LITTON, of St. Louis, for this species, which was collected by him some years since in Hardin county, Tennessee, associated with *Pentamerus galeatus* and other fossils of the age of the Lower Helderberg group.

LAMELLIBRANCHIATA OF THE LOWER HELDERBERG GROUP.

The physical conditions attending the deposition of the strata of the Lower Helderberg group were more favorable to the existence of this class of molluscs, than were those of the Clinton and Niagara groups in the State of New-York : there are, nevertheless, comparatively few species known at the present time. In the Tentaculite limestone the Aviculæ are very rare, or not occurring at all; while nearly all the species of the Shaly limestone are of this genus, and several occur in the Lower Pentamerus limestone. The aviculoid forms in the lower beds are gibbous, essentially equivalved shells, more nearly resembling Ambonychiæ than Aviculæ, but, so far as can be observed, wanting the external ligamental area which is so characteristic of some of the Lower Silurian species included in that genus. There are likewise a few Cypricardia-like forms, approaching in character to some species of the Clinton and Niagara groups, but which differ in their external aspect from most of those, in the presence of concentric ridges which are more or less strongly marked in the different species. With the exception of some of the Aviculæ and one or two other forms, all the species are very rare; there being, in all the collections made, no more than one or two individuals of each species.

Tellinomya nucleiformis (n. s.).

Plate XLIX. Fig. 1.

Shell subelliptical or oval-ovoid, the anterior extremity regularly rounded, posterior extremity somewhat obtusely angular; umbones prominent, finely striated concentrically; muscular impressions, in the cast, very prominent; crenulations on the hinge-line about twenty or twenty-one visible in the cast.

This shell has few distinguishing features externally, but is more inequilateral and more acute posteriorly than the Trenton species referred to this genus, and bears a more general resemblance to the modern NUCULA. There is no cartilage-pit beneath the beak, the crenulations in the cast being continuous.

Fig. 1. A cast of the left valve.

Geological position and locality. In the Tentaculite limestone, Winfield, Herkimer county.

Modiolopsis? dubius (n. s.).

PLATE XLIX. FIG. 2 *a* – *e*.

SHELL transversely elongated, more than twice as wide as long: ventral and cardinal margins nearly parallel, the base sometimes a little concave; umbones nearly at the anterior extremity, subacute, with an obtusely angular ridge extending from the beak obliquely backwards; posterior extremity more or less rounded, or obliquely subtruncate.

SURFACE finely striated, and marked at intervals by stronger wrinkles of growth.

The specimens examined exhibit considerable variety in the strength of surface-marking; owing, no doubt, in some measure, to the degree of exfoliation, and to maceration previous to imbedding. The oblique ridge along the posterior umbonal slope is often indistinct, though it exists in well-preserved specimens. In the only specimen seen with the two valves in connexion, there is a distinct external ligamental area, and an ovate or cordiform escutcheon beneath the beaks in front.

Although resembling in form some species of ORTHONOTA, it does not present the plications along the hinge-line which mark the typical species of the genus; and though wanting in some of the characteristics of the MODIOLOPSIS, I have referred it with doubt to the latter genus.

Fig. 2 *a*. The right valve of a specimen which is slightly imperfect at the posterior extremity.

Fig. 2 *b*. Cardinal view of the same. (The apparent gaping at the posterior extremity is due to imperfection of the specimen.)

Fig. 2 *c*. The right valve of this species.

Fig. 2 *d*. The left valve of a larger individual.

Fig. 2 *e*. A fragment of limestone preserving the separated valves of several individuals.

Geological position and locality. In the Tentaculite limestone, Winfield, Herkimer county.

Anatina? sinuata (n. s.).

PLATE XLIX. FIG. 3 *a* – *d*.

SHELL thin, equivalve, compressed, inequilateral, subrhomboid, with the posterior side much wider than the anterior; posterior? rounded, much compressed near the extremity, with a distinct shallow groove extending from near the beak obliquely to the postero-basal margin, and a second broad groove extending from the hinge-line, immediately behind the beak, vertically to the base of the shell, each one producing a slight sinuosity in the margin of the shell: umbones vertical, or not perceptibly inclined to either side of the shell; anterior cardinal slope nearly flat, compressed and subalate.

SURFACE concentrically marked with fine subimbricating striæ, which are undulated in passing over the depressed lines on the anterior side of of the shell.

This fossil, from the characters preserved, is similar to some forms of ANATINA; but from the imperfection of the specimens examined, its true relations cannot be satisfactorily determined, and I can only refer it provisionally to this genus till we shall obtain a better knowledge of its characters. It possesses external characters extremely different from any other fossil which has come under my observation.

Fig. 3 *a*. The right valve? of a specimen in which the two extremities are imperfect.

Fig. 3 *b*. Cardinal view of the same. (The compression of the anterior extremity is not distinctly represented.)

Fig. 3 *c*. The right valve? of a specimen from which the shell is nearly exfoliated, and the beaks broken off.

Fig. 3 *d*. Profile view of the same.

Geological position and locality. At the base of the Lower Helderberg group, Winfield, Herkimer county.

GENUS CYPRICARDINIA (n. g.).

THERE are a few species of shells in this group of strata which have the general form of CYPRICARDIA; being very inequilateral, with a more or less distinctly defined oblique posterior ridge, the umbones anterior or subanterior and little elevated. The surface is concentrically grooved, or more or less distinctly marked by prominent ridges or imbricating lamellæ, and, on some of them, these lamellæ are radiatingly striated or cancellated. A single well-preserved specimen shows no external ligamental area. In some species, the postero-cardinal margin becomes alate or subalate. They bear some general resemblance to MODIOLOPSIS; but the shell is apparently thicker, and is more strongly marked by concentric striæ and with a less conspicuous anterior muscular prominence, while the aspect and general expression of the shells are quite distinct.

Until something more definite is known of the hinge-structure, I propose the above name as a provisional one for the convenience of designation.

Cypricardinia lamellosa (n. s.).

PLATE XLIX A. FIG. 1 *a*, *b*, *c*.

SHELL subovoid, gibbous : umbones slightly elevated; anterior extremity abruptly rounded and extending little beyond the beak, somewhat contracted on the base anterior to the middle, with an undefined depression extending thence nearly to the umbones; posterior slope prominent, with a scarcely defined ridge; cardinal margin compressed, obliquely subtruncated above and rounded towards the base.

SURFACE marked by strong elevated distant lamellæ; the surface of each one showing, under a magnifier, distinct radiating striæ, and sometimes another set of striæ cancellating the first.

Flg. 1 *a*. A specimen, natural size.

Fig. 1 *b*. The same enlarged to nearly three diameters.

Fig. 1 *c*. Cardinal view of the same enlarged. Another specimen examined is about twice the size of the one figured, or equal to two-thirds the size of figs. 1 *b* and 1 *c*.

Geological position and locality. In the shaly limestone of the Lower Helderberg group, associated with *Spirifer*, *Rhynchonella* and *Atrypa* : Albany county.

Cypricardinia dorsata (n. s.).

PLATE XLIX A. FIG. 2.

SHELL transversely elongated, scarcely gibbous : umbones depressed; anterior extremity rounded; posterior extremity obliquely subtruncate; the cardinal margin compressed, with an obtuse oblique ridge separating it from the body of the shell.

SURFACE marked by concentric ridges, which are more conspicuous on the anterior part of the shell, becoming obsolete on the middle and posterior portions (perhaps from maceration and wearing before the shell was imbedded).

The only specimen observed is in a shaly limestone, and is not well preserved. It differs, however, conspicuously from any other species seen in this group.

Fig. 2. The right valve of this species.

Geological position and locality. In the shaly limestone near the upper part of the Lower Helderberg group : Near Hudson, Columbia county.

Cypricardinia sublamellosa (n. s.).

PLATE L. FIG. 1.

SHELL transversely elongated; anterior extremity contracted; umbones very depressed; posterior slope convex, without a defined ridge; extremity somewhat acutely rounded.

SURFACE marked by rounded concentric striæ or ridges, which are more prominent on the posterior half of the shell.

A single specimen only has been observed.

Fig. 1. The right valve, natural size.

Geological position and locality. In the compact calcareous layers of the middle portion of the Lower Helderberg group : Helderberg mountains, Albany county.

Cypricardinia concentrica (n. s.).

PLATE L. FIG. 2.

SHELL oval-ovate, broader behind, compressed, narrowed and regularly rounded at the anterior end : umbones extremely depressed; hinge-line scarcely curved ; base regularly curving; posterior extremity somewhat abruptly rounded : a defined oblique ridge from the beak backwards.

SURFACE marked by strong concentric ridges, which are more distinct on the anterior and central portions of the shell, and become obsolete above the oblique ridge.

Fig. 2. The right valve of this species. The figure represents the shell as more acute anteriorly, and more oblique on the posterior margin than it is in reality, while the concentric ridges are represented as bending too acutely upon the posterior ridge.

Geological position and locality. In the compact calcareous layers of the central portions of the Lower Helderberg group : Schoharie county.

Cypricardinia crassa (n. s.).

PLATE L. FIG. 3.

SHELL thick, subrhomboidal : umbones depressed; anterior side short, rounded; posterior side much wider, somewhat obliquely truncated; hinge-line short, the oblique ridge extending to the postero-lateral margin.

SURFACE marked by a few broad, distinct, thickened lamellæ, and finer striæ of growth.

Fig. 3. The right valve, natural size. The posterior side is somewhat broken and obscure.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Schoharie.

In the first volume of the Palæontology of New-York, I have designated by the generic name Ambonychia a group of certain species which are allied in form and other external characters; but not having at that time seen the structure of the hinge, the generic description could not be founded on the study of these most essential parts. Since then I have obtained casts of *A. radiata*, and separated valves of one or two other species; and I have also seen some very fine specimens of *A. orbiculata* and others in the collections of the Geological Survey of Canada. These examples show that *A. radiata* and *A. carinata* have a single large and nearly central muscular impression; one specimen of the former showing distinctly two strong teeth beneath the beak, while at the posterior extremity of the hinge-line there are three lateral elongate and slightly curving teeth, the hinge-area being striated longitudinally. The cardinal teeth of the *A. carinata* are similar, but there is some obscurity in regard to the lateral teeth. These characters probably exist in all those with extended and subspiral umbones and striated or costate surfaces; but in the concentrically striated forms, this hinge structure is somewhat varied, and some of them at least exhibit double muscular impressions, one large subcircular pit lying at the anterior extremity.

Ambonychia radiata.

The illustration is from a cast of this species (the beak being left out), showing the cardinal and lateral teeth, the muscular and palleal impressions. The margins of the external costæ are preserved in the margin of the cast.

The *A. obtusa*, and an allied form from Tennessee, have the same general characteristics; while there is a distinct external ligamental area, which is likewise seen in other species.

A farther examination has shown that some species heretofore referred to the Genus Modiolopsis have this structure of hinge, muscular impres-

sions, etc.; while some of those from the Trenton limestone, which I referred to EDMONDIA, have likewise essentially the same structure of hinge as the *Ambonychia obtusa*. The *Edmondia ventricosa*, which is farthest removed from the Ambonychia type, has a wide and deep ligamental area, with three or four oblique teeth beneath the beak, and three lateral oblique teeth at the posterior extremity of the cardinal line.

This character of hinge, although so nearly like that of *Ambonychia radiata*, is nevertheless accompanied by a strong anterior muscular impression, and a less conspicuous posterior one, which renders it necessary to separate the two forms. In *Edmondia ventricosa*, where the hinge-line is less curved than in any other form at present known to me, the structure bears some resemblance to that of MACRODON; but the cardinal line is never so straight, the posterior teeth are not so nearly parallel with the direction of that line, and the shells are externally marked by concentric striæ or laminæ, and never by radiating costæ as in that genus or in the ark-shells of more recent periods.

In view of the knowledge we now possess, it becomes necessary to separate the fossils formerly united under the Genus AMBONYCHIA, and to place those having double muscular impressions, under one division; including with them some forms that have been referred to MODIOLOPSIS and EDMONDIA. At the same time we are not fully aware of the internal characters of MODIOLOPSIS*; but the typical forms of that genus do not present the exterior features which mark those of the group here noticed, and I shall venture to separate the latter under the name PALÆARCA.

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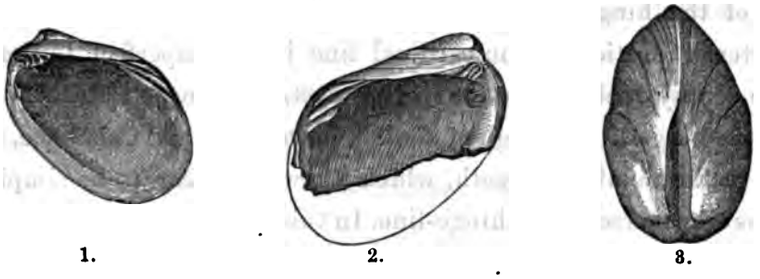
* The type of the Genus MODIOLOPSIS is the *M. modiolaris* (*Cypricardites modiolaris* of CONRAD = *Pterinea modiolaris* of the same author, 1838). The Genus CYPRICARDITES, as constituted by Mr. CONRAD, embraced species of more than a single genus. The *C. bisulcata* (1841) is the *Pterinea bisulcata* of the same author (Report of 1838, p. 116); and this fossil is the type of the Genus GRAMMYSIA (*G. hamiltonensis*) of DE VERNEUIL. It is probable that a careful investigation of the numerous species of Lamellibranchiata in the Hamilton and Chemung groups will throw some light upon the generic relations of these fossils with those of the lower rocks. An examination of the casts of *M. modiolaris*, and other allied forms in the Hudson-river group, has not yet disclosed the structure of the hinge; and the large anterior muscular scar is equally common to those species and many similar forms in the Hamilton group, of which we know nothing of the hinge structure.

Palæarca ventricosa.



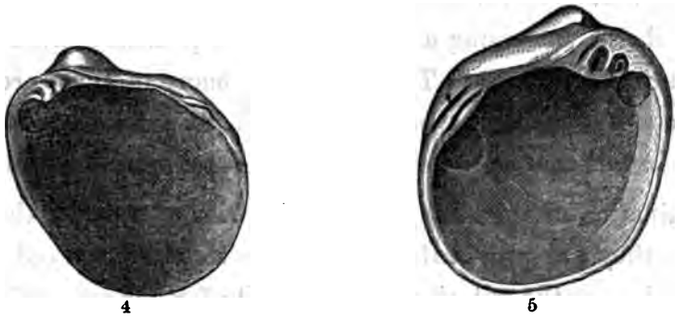
1. 2. 3.

Fig. 1. The interior of the right valve of this species, showing the anterior and posterior teeth, the ligamental area and muscular impressions.

Fig. 2. The left valve of an older specimen, in which the anterior teeth appear to have been partially obliterated by age. The ligamental area is proportionally wider than in fig. 1.

Fig. 3. A cardinal view of the exterior of the same species, showing the ligamental area.

Palæarca saffordi.



4 5

Fig. 4. The interior of the right valve, showing the hinge-teeth and ligamental area, muscular impressions, etc. The ligamental area is very narrow in the specimen.

Fig. 5. The left valve, showing a wider ligamental area, with the anterior teeth less strongly defined than in the preceding figure, which represents the prevailing character of this part of the shell. The posterior teeth are more oblique and more strongly defined than in fig. 4.

The posterior muscular impression is but faintly defined, though distinctly visible in several specimens, occupying a larger area than the posterior impression; the shell at that point being much thinner, and often worn through from the exterior in the specimens examined.

This species, like the preceding, occurs in strata of the age of the Trenton limestone in Tennessee, and approaches in form some of the species in New-York, the hinge structure of which is yet unknown.

There are, also, besides these, some species in the strata under consideration which resemble the Palæarcæ of the Lower Silurian rocks, both in their general external features and in the large muscular scar. In several forms, however, they approach AVICULA, and do not appear to

have had an external ligamental area. A single cast has, upon the anterior portion of the hinge-line, as many as six or seven crenulations; while the posterior portion of the cardinal line is too imperfect to show the remains of any such characters in that part, had they existed. This feature of the hinge-line, though of similar character to the Palæarcæ, differs greatly in the number of teeth, which likewise appear to be simple crenulations transverse to the hinge-line. In this feature, as well as in certain external characters, some of these shells resemble PTEROPERNA; while the Palæarcæ, on the other hand, approach in character to BAKEWELLIA.

Among the fossils of this group are some which, in single valves, present the characters of AVICULA, and have heretofore been referred to that genus; but an examination of specimens which preserve the two valves shows that both valves are gibbous, and that they are essentially equivalved shells, possessing a more or less conspicuous alation upon the anterior and posterior sides. The surfaces of many of these are marked by strong concentric laminæ of growth and fine radiating striæ, corresponding in this character to the surface of some species of AMBONYCHIA.

An examination of the casts from the interior of some of these shells shows that they are provided with a very strongly marked muscular impression close to the anterior extremity. On farther comparison, these forms have much resemblance to some in the Upper Helderberg group; one of which was figured in the Geological Report of the Fourth District in 1843, under the name of *Pterinea? cardiiformis*. This species is expanded on the posterior cardinal line, and has an anterior lobe or wing separated by a sinus from the body of the shell, and possessing a very large muscular impression which lies just within this anterior lobe.

It would appear, therefore, that we have a group of shells, possessing the characters here noticed, and, so far as now known, beginning their existence in the Lower Helderberg group, and extending through the Oriskany sandstone, the Upper Helderberg limestone and the Hamilton group. Although the hinge-structure has not been fully determined, they are clearly separable from AMBONYCHIA, taking *A. bellistriata* and *A. radiata*

as the types, by the strong anterior muscular impression, which does not exist in those shells, and by the numerous teeth in the anterior part of the hinge.

For these forms I propose the generic name *Megambonia*.

Genus Megambonia (n. g.).

Shell equivalve or subequivalve, inequilateral, subovoid, usually very gibbous in the middle and towards the umbones : anterior side often lobed or auriculate, a strong muscular impression occupying a considerable portion of this part of the shell; posterior cardinal margin expanded, more or less compressed and frequently alate : hinge-line crenulated on the anterior end; teeth numerous.

Surface marked by concentric laminæ of growth, and often by fine radiating striæ.

The entire structure of the hinge-line is unknown; and the grouping of the species has been mainly determined by external form and marking and the large anterior muscular scar, which is a conspicuous feature in most of the species.

Megambonia suborbicularis (n. s.).

Plate XLIX. Fig. 4 *a*, 4 *b* = 5 *b*; and Plate XLIX A. Fig. 5.

Shell depressed-suborbicular; length and greatest width about equal : umbones rounded, moderately elevated, closely incurved; hinge-line less than the greatest width of the shell : anterior muscular impressions large, moderately deep.

The specimens examined are casts, one of which preserves the form entire, showing some remains of concentric striæ. The muscular impressions are close to the anterior margin, which is compressed from a little distance below.

Fig. 4 *a*. The left side of the cast, showing the muscular impression.

Fig. 5 *b* (by error for 4 *b* on plate). Profile view from the posterior side.

PLATE XLIX A.

Fig. 5. A cast of the left valve of the same species.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Near Carlisle, Schoharie county.

Megambonia spinneri (n. s.).

PLATE XLIX. FIG. 5 *a*, *b*, *c*.

SHELL subovoid, gibbous in the middle, with a broad prominent ridge extending from the umbones to the base of the shell, anterior to which it is abruptly compressed; posterior side less compressed; base rounded: umbones prominent, much elevated above the hinge-line, and not incurved in the cast: muscular impressions strong and deep, close to the anterior margin and just below the cardinal line, pointing upwards (not well represented in fig. 5 *a*); the cardinal line, anterior to the beaks, marked by impressions of six or more transverse interlocking teeth.

A single specimen only, a cast, has been seen; but the characters are sufficiently distinctive. It differs from the *M. suborbicularis* in the umbonial ridge, which extends on each side in a slightly curving direction, more than half way to the base: the beaks are more elevated and less incurved, and the muscular scars much more prominent.

Fig. 5 *a*. The left side of the cast, showing the form, the muscular scar, and elevation of the beak.

Fig. 4 *b* (by error for 5 *b*). Profile view from the posterior side.

Fig. 5 *c*. Cardinal view, showing the prominence of the muscular scars.

Geological position and locality. In the lower beds of the Lower Helderberg group: Near Mohawk, Herkimer county. [From Hon. F. S. SPINNER.]

Megambonia aviculoidea (n. s.).

PLATE XLIX. FIG. 7 *a*, *b*, and 8; and PLATE XLIX A. FIG. 8.

SHELL obliquely ovoid, alate on the posterior side and slightly sinuate below, with a small anterior lobe covering the muscular impressions, very gibbous in the middle and towards the umbones, compressed on the posterior side, and the wing not separated by a sinus from the body of the shell: beaks elevated and incurved; hinge-line straight.

SURFACE marked by fine concentric striæ of growth, with unequal stronger laminæ; the character being uniform on the body of the shell, and upon the alate portion.

Fig. 7 *a*. The left valve of a young shell.

Fig. 7 *b*. The left valve of a larger individual. [The anterior lobe or wing is rarely discernible in the young shells.]

Fig. 8. A full-grown? individual preserving in part the anterior and posterior extensions, the shell being removed from the central prominent part of the fossil.

PLATE XLIX A.

Fig. 8. The left valve of a specimen of the same species.

Geological position and localities. In the lower and middle portions of the Lower Helderberg group : Helderberg mountains, Albany county; Schoharie; Winfield, Herkimer county, and other places.

Megambonia rhomboidea (n. s.).

PLATE XLIX. FIG. 9.

SHELL subrhomboid, expanding towards the posterior side, extremely gibbous in the middle, abruptly compressed in front, and concave between the umbones and the anterior auriculate portion of the shell; posterior cardinal slope subalate (imperfect in the specimen), compressed at the margins : umbones prominent, incurved.

SURFACE marked by concentric lamellose striæ, with a few radiating lines where the shell is partially exfoliated.

The specimen figured shows a slight inequality in the valves, which does not appear to be due to accident.

Fig. 9. The left valve, imperfect at the posterior side, and also at the anterior side, though the latter is not shown in the figure.

Geological position and locality. In the limestone of the Lower Helderberg group: Near Carlisle, Schoharie county.

Megambonia mytiloidea (n. s.).

PLATE XLIX A. FIG. 3 *a*, *b*.

SHELL subovoid, slightly inequivalve (from accident or otherwise), gibbous in the middle : umbones prominent, acute, scarcely incurved; margins regularly curvilinear, without visible alation on the posterior side or projection in front.

SURFACE marked by fine lamellose concentric striæ.

The shell is exfoliated partially from the right valve, and entirely from the opposite valve.

Fig. 3 *a*. The right valve of the specimen. Fig. 3 *b*. Profile view of the same.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains.

Megambonia ovoidea (n. s.).

PLATE XLIX A. FIG. 4 *a*, *b*.

SHELL obliquely subovoid, the right valve a little the more prominent, very gibbous in the middle and upper portions : umbones prominent, rounded, incurved over the hinge-line, and bending forward; posterior cardinal margin compressed, not alate, abruptly rounded in front, with a more prominent lobe covering the muscular scar : a scarcely perceptible sinus separates this lobe from the body of the shell.

SURFACE marked by lamellose concentric striæ, with some stronger lines of growth, and by fine equal radiating striæ [only visible on the right valve of the specimen.]

The slight inequality of the valves does not appear to be due to accident; and the same character holds true of the two preceding species, the right valve being a little less convex.

Fig. 4 *a*. The left valve of the specimen.

Fig. 4 *b*. Profile of the same, looking upon the cardinal line. The beak of the right valve is broken off.

Geological position and locality. In the lower part of the Lower Helderberg group : Schoharie county.

Megambonia obscura (n. s.).

PLATE XLIX A. FIG. 7.

SHELL subelliptical, elongate, depressed-convex; posterior slope compressed, not alate : beaks prominent, subacute.

SURFACE marked by concentric lamellose striæ, which are nearly obliterated in the specimen.

The antcrior part of the shell, just below the beaks, is broken off, and the characters are all obscure.

Fig. 7. The right valve of the specimen.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Schoharie county.

Megambonia lata (n. s.).

PLATE L. FIG. 4.

SHELL broadly ovate or suborbicular, gibbous in the middle and upon the umbo, and gradually sloping to the sides and base; posterior slope expanded, not alate, compressed; anterior cardinal extremity abruptly rounded : hinge-line less than the width of the shell below.

SURFACE concentrically striated.

This species bears considerable resemblance to *M. orbicularis*; but it is more oblique on its anterior slope, and the posterior basal portion is more expanded.

Fig. 4. The left valve of this species.

Geological position and locality. In the shaly limestone of the central part of the Lower Helderberg group : Schoharie county.

Megambonia oblonga (n. s.).

PLATE L. FIG. 5.

SHELL somewhat elongate-ovate; hinge-line short, and the shell gradually expanding towards the posterior extremity, gibbous from below the

middle towards the beaks; a somewhat defined ridge extending from about the middle of the shell to the umbo, which is prominent and elevated above the hinge-line; beak incurved: anterior side subauriculate, with a shallow undefined sinus separating this portion from the body of the shell, the sinuosity being perceptible in the outline of the margin; posterior cardinal slope moderately expanded, but not alate.

SURFACE marked by concentric lamellose striæ.

In this and the preceding species, the shell has been partially worn or exfoliated, so that the original surface characters are not fully preserved: the form of the shells, however, as shown in the figures, is sufficiently distinctive.

Fig. 5. The left valve of this species.

Geological position and locality. In the shaly limestone of the central portion of the Lower Helderberg group: Schoharie county.

Megambonia cordiformis (n. s.).

PLATE L. FIG. 6 *a*, *b*.

SHELL cordiform, extremely gibbous from the base upwards to the umbones, which are elevated and incurved, not compressed at the basal or lateral margins; anterior cardinal extremity slightly auriculate, the prominence covering the muscular impression small.

SURFACE marked by concentric lamellose striæ.

The only specimen which I have seen is apparently somewhat vertically compressed, and the posterior cardinal slope is worn off from exposure upon the surface of the stratum. If compressed in the opposite direction, it would have somewhat the shape of *M. lata* (fig. 4); but it is less oblique, and the anterior extension appears never to have been as great.

Fig. 6 *a*. Profile view from the anterior side of the shell.

Fig. 6 *b*. View of the right valve, having the posterior cardinal extension abraded.

Geological position and locality. In the central portion of the Lower Helderberg group: Schoharie county.

Megambonia ovata (n. s.).

PLATE L. FIG. 7.

SHELL nearly symmetrically ovate, the anterior side a little more regularly converging than the opposite, becoming very gradually and equally gibbous from the base towards the umbo : beak subacute ; anterior side subauriculate, with a moderately developed muscular scar.

SURFACE of cast preserving marks of concentric laminæ or wrinkles, and a few stronger undulations.

This species is somewhat common; but I have been unable to obtain any other than the casts of single valves, the nature of the matrix being unfavorable to the preservation of the shell. In its symmetrically ovate form, and small anterior musculor scar, it is quite distinct from the other species described.

Fig. 7. The cast of the right valve.

Geological position and locality. In the compact beds of the shaly limestone of the Lower Helderberg group : Helderberg mountains, Albany county.

Avicula [?] naviformis.

PLATE XLIX A. FIG. 9 *a*, *b*, *c*.

Avicula naviformis : CONRAD, Journal of the Academy of Natural Sciences, 1842, Vol. viii, pa. 210, pl. 12, f. 11.

"LOWER VALVE subrhomboidal, slightly ventricose, obscurely radiated. Summit of umbo much above the cardinal line : anterior wing triangular ; posterior wing elongated, angulated at the extremity, which extends beyond the line of the posterior extremity of the valve : umbonial slope rounded."

The figures 9 *a* and 9 *c* are from authentic specimens. The posterior extremity is not so much produced as in the figure of Mr. CONRAD. The specimens observed are for the most part casts, showing only partially the concentric and obscure radiating striæ. All the specimens yet seen are of the left valve, one, only, preserving a small portion of the right wing. Notwithstanding its strongly alate character, I have been

inclined to refer it to the Genus MEGAMBONIA; but have been unable to obtain sufficient evidence to determine this point.

Professor M'COY refers this species of CONRAD to the Genus PTERINEA, regarding it as only a variety of the *Avicula* (*Pterinea*) *retroflexa* of WAHLENBERG. The concentric striæ or lamellose elevations are never so strong or so regular in the American species as in the Swedish specimens of *A. retroflexa*; and since we do not yet know the hinge structure of the *A. naviformis*, I leave it as described by Mr. CONRAD, under the Genus AVICULA.

Fig. 9 *a*. A left valve preserving the entire form, with some remains of the shell, showing the concentric lamellose markings and the radiating striæ.

Fig. 9 *c*. A larger individual in which the radiating striæ are scarcely shown.

Fig. 9 *b*. A large individual, in which the shell is better preserved than in the other specimens : the umbo is proportionally less elevated, and the continuity of the hinge line is interrupted or obscured by the surrounding stone. The radiating striæ are a little too strong in the figure.

Geological position and locality. In the pentamerus limestone of the Lower Helderberg group : Schoharie, and Helderberg mountains.

Avicula obscura (n. s.).

PLATE XLIX. FIG. 6.

SHELL subequilateral, circular below and on the sides, depressed-convex in the middle; anterior wing narrow and short; posterior wing wider, and extending as far or farther than the posterior extremity of the valve (imperfect in the specimen).

SURFACE marked by unequally dichotomizing radii, which are cancellated by concentric laminæ, the latter becoming much stronger on the lower part of the shell.

The specimen figured is the interior of a right valve, having the anterior wing nearly obliterated, and the other broken off at some distance from the extremity. It appears to have been a true *Avicula*, and is the only one observed in the Tentaculite limestone.

Geological position and locality. In the Tentaculite limestone : Schoharie county.

Avicula subequilatera (n. s.).

PLATE XLIX A. FIG. 6.

SHELL semielliptical, wider than long; hinge-line less than the greatest width of the shell below, depressed-convex in the middle; umbones appressed; base broadly rounded : anterior wing small, scarcely separated by a shallow sinus from the body of the shell; posterior wing large, separated from the body of the shell by a broad shallow sinus, from which the wing bends slightly outwards.

SURFACE concentrically striated, without visible radiating striæ.

The shell is mostly exfoliated from the specimen, and its entire surface characters cannot be determined.

Fig. 6. The left valve of this species.

Geological position and locality. In the upper part of the pentamerus limestone of the Lower Helderberg group : Schoharie county.

Avicula tenuilamellata (n. s.).

PLATE LI. FIG. 1 & 2.

SHELL orbicularly subovate : left valve scarcely convex; right valve flat; hinge-line straight, shorter than the greatest width of the shell : anterior wing small, short, acute, separated from the body by a deep narrow sinus, not extending as far forward as the anterior margin of the shell; posterior wing short, broader than the anterior, acute at the extremity, not extending to the line of the posterior margin of the shell.

SURFACE marked by a few unequal concentric wrinkles, and by fine, closely arranged, elevated, subimbricating, lamellose striæ, which extend over the wings in like manner. Central portion of the shell marked by faint radiating striæ.

The specimens which have been seen are of the right and left valves of different individuals; the right valve being nearly flat, and the opposite one very slightly convex. The shell is almost entirely removed from two of these specimens, and the cast of one shows some faint radiating striæ; while in another specimen of the right valve, having the surface much worn, the radiating striæ are preserved on the central portions of the shell, but do not seem to have extended to the sides, which are marked only by the concentric lamellæ.

Fig. 1. The right valve, having the shell nearly exfoliated.
Fig. 2. The left valve of the same species, preserving some small pieces of the shell.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains, Albany and Schoharie counties.

Avicula spinulifera (n. s.).

PLATE LI. FIG. 3 & 4.

SHELL obliquely and broadly subovate, inequilateral : posterior side produced and regularly rounded; anterior side shorter and regularly curved, the basal margin forming part of an elliptic curve; hinge-line nearly equal to the greatest width of the shell : left valve moderately convex, the greatest convexity being near the middle or towards the umbo; right valve nearly flat, or very slightly convex : anterior wing triangular, extending as far as the anterior margin of the shell, ornamented on its upper margin with a few short spines; posterior wing broader, and extending scarcely as far as the posterior margin of the shell.

SURFACE marked by numerous strong radiating striæ which are unequally dichotomized, and crossed by regular elevated subimbricating lamellose striæ, giving the entire surface a cancellated appearance. The radiating striæ do not appear on the wings of the left valve, but upon these parts the concentric striæ are closely crowded : on the right valve, some faint indications of radiating striæ appear upon both the wings.

The only specimens seen are the interior of a right valve from which most of the posterior wing is broken, and the impression made by the exterior of the left valve,

with some fragments of the shell itself. The form and surface characters are so similar, and the greater and less convexity of the two valves so nearly corresponding to the usual relations of these parts, that I have inferred these specimens to be of the same species. The small spines, which exist on the upper margin of the anterior wing of the right valve, are not shown in the figure.

Fig. 3. The interior of the right valve, from which the posterior wing is nearly removed.
Fig. 4. The impression or mould of the exterior surface of the left valve of the same species.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains, Albany county.

Avicula schohariæ (n. s.).

PLATE LI. FIG. 5 & 5 *a*.

SHELL subquadrate, nearly equilateral : left valve gibbous in the middle and flattened towards the umbo; hinge-line scarcely equalling the greatest width of the shell : anterior and posterior sides nearly equal; entire basal margin forming a part of a regular elliptic curve : posterior wing small; anterior wing unknown.

SURFACE of the body of the shell and of the posterior wing marked by numerous round radiating and dichotomizing striæ, and these are crossed by regular subequidistant subimbricating lamellose striæ which are less conspicuous than the radiating striæ.

The specimen is marked about halfway from beak to base by a strong concentric ridge, or line of interrupted increase, which shows the form of the shell at that period of its growth : the portion of the shell above this line is quite flat, or a little concave.

Fig. 5. Left valve of this species. The line apparently corresponding to the anterior wing in the figure is an accidental ridge in the stone.
Fig. 5 *a*. Enlargement of a portion of the surface, to show the round radiating striæ and distant lamellose lines of growth.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Schoharie county.

Avicula umbonata (n. s.).

PLATE LI. FIG. 6.

SHELL rhomboid, nearly once and a half as long as high : anterior margin broadly rounded; posterior side narrower and acutely rounded, very convex in the middle and upon the umbo : anterior wing small, acute, extending a little beyond the anterior margin of the shell, and separated from the body of the shell by a narrow well-marked sinus; posterior wing larger, separated from the body of the shell by a broad defined sinus.

SURFACE marked by concentric lamellose striæ, which are closely crowded on the wings.

The specimen has nearly all the shell exfoliated, and the small portion remaining is somewhat imperfect, the cast retaining the impressions of the lamellose striæ.

Fig. 6. The left valve, having the posterior wing broken off.

Geological position and locality. In the pentamcrus limestone of the Lower Helderberg group : Schoharie county.

Avicula manticula.

PLATE LI. FIG. 7 & 8.

Avicula manticula : CONRAD, Jour. Acad. Nat. Sciences, 1843, Vol. viii, pa. 241, pl. 12, f. 18.

SHELL "obliquely ovate, acute : anterior wing short and triangular; "lower valve with unequal, prominent, rather distinct radii; umbo "narrow, tapering to the summit, which is elevated above the cardinal "line; basal margin rounded or arched."

The original specimen from which Mr. CONRAD made his description is figured on Plate LI. It measures two and a half inches from beak to base, and its greatest width is one inch and a half. The anterior wing is very small, and the posterior wing too imperfect to be determined. The upper part of the shell is very gibbous. The surface is marked by narrow radiating ribs, of which about ten are stronger than the others, having one or two smaller ones between. This character is not well represented in the figure. In the specimen, the radiating costæ have been originally crossed by concentric striæ, some of which were strongly elevated.

Fig. 7. The left valve of this species.

Fig. 8. The left valve of a smaller individual.

Geological position and locality. In the pentamerus limestone of the Lower Helderberg group : Schoharie county.

Avicula obliquata (n. s.).

PLATE LI. FIG. 9 & 10.

SHELL very obliquely subovate, arcuate ; anterior side straight above and broadly curving below : anterior wing very small ; posterior wing large, not reaching as far as the margin of the shell, separated by a well-defined sinus from the body of the shell, abruptly rounded on the postero-basal margin.

SURFACE marked by obscure radiating costæ and concentric elevated lamellæ, the latter of which only appear on the wing.

Fig. 9. The interior of the left valve, showing obscurely the external costæ. [From imperfection in the specimen, the sinus in the external margin, between the wing and the body of the shell, is represented as too abrupt.]

Fig. 10. A cast of the valve, which preserves only the remains of the concentric striæ.

Geological position and locality. In the pentamerus limestone of the Lower Helderberg group : Schoharie county.

Avicula æquiradiata (n. s.).

PLATE LI. FIG. 11.

SHELL very depressed-convex, subequilateral, pectiniform ; margin regularly rounded below, and sinuate below the wings : wings subequal.

SURFACE marked with fine equal radiating threadlike striæ, increased by dichotomizing or interstitial addition, and crossed by fine concentric striæ and a few distant undulations, which are more crowded on the umbo, and give a wrinkled appearance to that part of the shell. The radiating striæ are much finer on the posterior wing, and not visible on the anterior.

Fig. 11. An imperfect specimen of the left valve.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Schoharie county.

Avicula communis (n. s.).

PLATE LII. FIG. 1 – 7; and PLATE LIII. FIG. 1, 4 & 6.

SHELL obliquely ovate; the left valve gently convex in the middle, and becoming gibbous towards the beak, which in the young shell is narrow and projecting above the hinge-line : right valve flat or gently concave in the middle and below, and becoming slightly convex on the umbo; anterior side gently curving to the base which is broadly rounded, the curvature of the posterior side being more abrupt : anterior wing small, trigonal, obtuse at its extremity, strongly defined from the body of the shell; posterior wing three times as long as the anterior wing, obtusely or subacutely pointed, extending more or less beyond the margin of the shell, concave on the outer or lateral margin, its junction with the body of the shell not strongly defined.

SURFACE of left valve marked by slender, sharply defined, rounded radii, the principal of which are distant from two to four or five times their width, and the spaces occupied by one, two or three finer interstitial radiating striæ (these radii are but faintly, and sometimes not at all perceptible on the posterior wing, except along its upper margin, while they are not seen on the anterior wing); concentrically marked by fine lamellose striæ, which, in the more perfectly preserved surfaces, are elevated and subimbricating : these striæ are usually conspicuous on both the anterior and posterior wings. Surface of the right valve marked by broader and scarcely elevated radii and less defined concentric striæ.

This species is the most common form of AVICULA in the shaly limestone, or indeed in any part of the Lower Helderberg group. In its different stages of development, and different degrees of preservation, it presents considerable variety of aspect and surface marking. In many of the casts the stronger radii are interrupted, and frequently with great regularity, by the concentric laminæ, which leave depressions cutting the radii : others are less regularly interrupted.

PLATE LII.

Fig. 1. A cast of the left valve which has been transversely compressed, elevating the anterior and depressing the posterior wing. The radii are pretty regularly interrupted by the concentric striæ.

Fig. 2. A smaller individual in which the shell is well preserved, showing the stronger and intermediate finer radii. The anterior wing is not preserved, and the shell of the posterior wing is partially broken away. Some of the concentric striæ near the base are strongly elevated.

Fig. 3. The interior of the left valve of a specimen of this species, in which the anterior wing is imperfect, as well as the cardinal margin of the posterior wing. The depressions corresponding to the stronger and finer radii of the exterior are well preserved, while the concentric striæ upon the posterior wing are equally strong with those of the exterior of the shell.

Fig. 4. The cast of the interior of a smaller specimen, having the posterior side and extremity of the wing broken off. (The broader radiating spaces in the figure should be represented as the depressed portions, and the narrower as the elevated parts.)

Fig. 5. The right valve, from which the shell has been partially removed. The radii are much more equal than on the opposite valve. [The cardinal margin of the anterior wing is improperly represented in the figure.]

Fig. 6. The interior of a smaller specimen, in which the radii are more equal.

Fig. 7. A smaller individual (apparently of the same species), having the posterior side and base broken off, and the anterior side entire. (The radii are improperly represented, as in fig. 4). The surface of the specimen is marked by a few strong undulations or wrinkles.

PLATE LIII.

Fig. 1. A young shell of this species, which preserves the anterior and posterior wings entire, with the gibbous umbo and beak elevated above the hinge-line.

Fig. 4. A specimen of medium size, which is very gibbous above the middle and at the umbo. The wing is erroneously represented as too pointed, by leaving out a portion which is obscurely visible on the posterior sinuate margin.

Fig. 6. A similar specimen, in which the body of the shell is a little more oblique than usual. The posterior extension of the wing is broken off, so that the margin represented is not the natural one.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains, Albany county; Becraft's mountain, near Hudson; Schoharie, and other places.

Avicula pauciradiata (n. s.).

PLATE LII. FIG. 8.

SHELL elongate-ovate, rectangular to the hinge-line; length about once and a half the width : basal margin regularly curved, a little more produced on the posterior side, gibbous in the middle : anterior wing unknown; posterior wing large, triangular.

SURFACE marked by eight or nine broad strong ribs, which are depressed

in the centre or slightly dichotomizing : these are crossed by strong concentric lamellose striæ, which become very conspicuous on the wing, where no radiating striæ are observed.

The only specimen seen is the interior surface of a large left valve. The strong duplicating ribs, and the scarcely oblique direction of the body of the shell to the hinge-line, with the large posterior wing, are distinguishing features.

Fig. 8. The interior of the specimen described.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Schoharie.

Avicula textilis (n. s.).

PLATE LII. FIG. 9 & 10?; and PLATE LIII. FIG. 2, 3, 5, 7 & 10.

BODY of the shell obliquely subovate; length about once and a half the height, becoming regularly convex from the base, gibbous in the middle, and gently depressed along the line of junction with the posterior wing: ventral margin very regularly and broadly curved; hinge-line greatly extended : posterior wing long, nearly three times its greatest width, the extremity extending beyond the margin of the shell, the margin moderately sinuate.

SURFACE marked by regular strong radiating ribs, which, at the base, are distant from each other three times their width; the intermediate space marked by a central finer ray, and, on each side between it and the larger costæ, are one or two still finer rays, which are scarcely perceptible to the naked eye : these are crossed by concentric ridges, giving a cancellated surface and a slightly nodose character to the larger costæ. The wing is marked by strong radiating and concentric striæ, which are of nearly equal size, and slightly nodose at their junction.

The form of this shell, in its full-grown condition, with its strongly cancellated surface, sufficiently distinguishes it from any other species known to me in this group of strata.

fasciculate radii; the right valve, by more numerous, equal and finer radii : entire surface of both valves marked by equal, elevated concentric striæ and a few distant wrinkles or undulations. Anterior wing marked by concentric striæ and a few indistinct radiating striæ; posterior wing, in both valves, with fine equal radiating striæ.

This is a small pretty species of which we have, in a single individual, the two valves in connexion presenting the unequal convexity of ordinary Aviculæ. The markings are only obtained from the cast of the interior, and from the interior of separate valves, and are doubtless more strongly shown on the exterior of the shell than represented in the figures.

Fig. 8. A specimen showing the two valves connected at the hinge.
Fig. 9. The interior of a left valve of the same species.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains, and Schoharie.

Avicula securiformis (n. s.).

PLATE LIII. FIG. 11 – 14.

SHELL subrhomboid-ovate, slightly oblique; length and height varying from nearly equal, to the height one-fourth greater than the width, moderately convex in the middle and on the umbo : anterior margin long, slightly concave above and curving to the base; posterior margin below the sinus, somewhat abruptly curving into the broad rounded basal margin : anterior wing small, trigonal, subacute, distinctly separated by a sinus from the body of the shell; posterior wing large, subacute at the extremity, not strongly distinct from the body of the shell, extending as far as or a little beyond the margin of the shell; marginal sinuosity long and shallow.

SURFACE marked by moderately strong radiating costæ and strong elevated concentric striæ.

The specimens figured have the shell partially or entirely removed, and the radii are not so strong as the perfect specimens would show.

Fig. 11. A specimen of the left valve, in which the proportions of length and height are nearly equal. The deep marginal sinuosity of the posterior wing is exaggerated, from imperfection in the specimen.

Fig. 12. The left valve, preserving the form nearly entire; the upper part of the surface being exfoliated so as to obliterate the markings.

Fig. 13. The specimen is apparently the inner side of the right valve, and is quite flat. The broad costæ represented are the elevated spaces between the external costæ, as shown on the inside of the shell.

Fig. 14. A partial cast of the left valve of this species.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains, Hudson, Schoharie, etc.

Several other undescribed species of *Avicula** are known to occur in the rocks of this group; but up to the time of completing the plates (1857), no well-preserved specimens had been obtained. The numerous localities of this group of strata along the Hudson river from Rondout to the Helderberg mountains, and thence westward along the northern outcrops as far as Herkimer county, afford ample opportunities for increasing the number of species, not only of *Avicula*, but of all the Lamellibranchiata. The obtaining of these forms, however, is somewhat more difficult than of the Brachiopoda; and as more especial attention has been given to the collecting of the latter class of fossils, it is probable that, when compared with those described in this volume, a larger proportion of Lamellibranchiata will be discovered than of Brachiopoda.

This group, like all the others, presents a greater proportion of lamellibranchiate molluscs in its more eastern localities; while as they diminish to the westward, the Brachiopoda increase in numbers.

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* I have been unable to obtain a specimen corresponding to the *Avicula rugosa* of VANUXEM (Report, p. 112, f. 2), and this species is therefore omitted in my list of those belonging to this group.

GASTEROPODA OF THE LOWER HELDERBERG GROUP.

THE species of this class of fossils are much more numerous in the Lower Helderberg group, than in any of the preceding or succeeding palæozoic periods below the Coal measures. They include, moreover, the greatest extremes, as well as a great variety of forms. We have the slender spiral shells with numerous closely arranged volutions, as in MURCHISONIA and LOXONEMA, and the broad ovoid forms with one or two volutions at the apex; the slender forms with the volutions free, and the conical or broadly depressed-conical forms which are straight or nearly straight, having no evidence of convolutions whatever, or with a slight arcuation at the apex.

Notwithstanding all this variety of form and degree of development in the spire, there is but a single nodose species known to me in this period; and in this one, the nodes are rather like transverse interrupted ridges*. The surfaces of many species are spirally or longitudinally ridged, and often transversely or concentrically lamellose or lamellose-striate, while a few forms are strongly cancellate.

Two species of EUOMPHALUS are known in the strata of this age, and a single species of BELLEROPHON or BUCANIA. The few species of LOXONEMA and MURCHISONIA are unfortunately in the form of casts, and their study is thus rendered unsatisfactory.

A large number of the forms are such as are at the present time referred to the Genus CAPULUS of MONTFORT (PILEOPSIS of LAMARCK), with which ACROCULIA of PHILLIPS and PLATYCERAS of CONRAD are made synonymous. For certain other forms among these shells, Mr. CONRAD proposed

* The earliest nodiferous or properly spiniferous form of gasteropod occurs in the Oriskany sandstone, the casts of which are strongly nodose, and the shell ornamented with strong spines. The spine-bearing gasteropods are common in the Upper Helderberg group, and are known in the Hamilton group and in the Carboniferous limestones.

the name PLATYOSTOMA*: the latter, in some of its forms, approaches the Pleurotomariæ.

The forms illustrated in this volume, from the Lower Helderberg group and from the Oriskany sandstone, may afford the means towards a better arrangement of these very difficult subjects which have been referred to the genera cited.

The arrangement of the subjects upon the plates illustrating the Gasteropoda is not quite as coherent and systematic as I could have wished; but this has arisen from causes beyond my control. Some of the plates were engraved in 1847, when it was expected that the materials of the Clinton, Niagara and Onondaga-salt groups, together with the Lower Helderberg group and Oriskany sandstone, would constitute a single volume. It was at this time that Plates 56, 57, 60, 61, 62 & 64 were engraved, and the drawings for several other plates completed for engraving. The additional species subsequently obtained could not, therefore, be so well disposed as if all the materials had been before me at one time. The same remarks are true of some other portions of the volume.

The genera of Gasteropoda recognized in the Lower Helderberg group are the following, in the order in which they are described:

HOLOPEA (heretofore referred to LITTORINA), LOXONEMA, MURCHISONIA.	These genera occur, for the most part, in the lower portions of the group.
PLATYOSTOMA, STROPHOSTYLIS (n. g.), PLATYCERAS.	These genera are characteristic of the middle and the upper portions of the group, below the Upper Pentamerus limestone.
PLEUROTOMARIA, EUOMPHALUS, BUCANIA.	These genera characterize the upper portion of the group, or the Upper Pentamerus limestone, and rarely occur below that rock.

* This genus is not synonymous with PLATYSTOMA of HÖRNES, 1855; nor with PLATYSTOMA of KLEIN, 1753.

Holopea subconica (n. s.).

PLATE LIV. FIG. 1 *a*, *b*.

SHELL thin, subconical : spire sharply elevated; volutions five or more, somewhat flattened above, the last one ventricose below and subangulate on the periphery, equal in height to all the others; aperture round-ovate, entire, the outer lip acute at the margin and thickened within : columellar lip thickened, with a slight umbilical groove or depression upon the outside, not perforate.

SURFACE marked by fine concentric striæ of growth.

The only difference between this shell and the modern *Littorina* is in the greater thickening of the columella, and the slight depression between it and the body of the shell.

Fig. 1 *a*. View showing the aperture, which is represented with the peristome too much thickened.

Fig. 1 *b*. The anterior side of the same.

Geological position and locality. In the tentaculite limestone near Auburn, Cayuga county.

Holopea antiqua (VANUXEM sp.).

PLATE LIV. FIG. 2 *a*, *b*, & 3 *a*, *b*.

Littorina antiqua : VANUXEM, Geol. Report of the Third District of New-York, 1843, p. 112, f. 4.

SHELL subconic-ovoid : spire elevated, obtuse; volutions about four, regularly rounded, the last one ventricose; aperture rotund-ovoid : columella slightly reflexed.

SURFACE marked by fine striæ corresponding to the lines of growth.

This species occurs abundantly, in the form of casts, in the tentaculite limestone of Schoharie and Herkimer counties. The specimen figured as cited is smaller than the ordinary size of those which have fallen under my observation, and smaller than most of the specimens which have been marked with that name by Mr. VANUXEM.

Fig. 2 *a*. A cast of this species of the ordinary size.

Fig. 2 *b*. A similar cast, which is a little more ventricose.

Fig. 3 *a*. A cast of a larger specimen.

Fig. 3 *b*. The anterior view of a larger individual. The apparent extension of the shell on the lower side is a misrepresentation of the artist.

Geological position and locality. In the tentaculite limestone : Helderberg mountains, Schoharie; Litchfield and Winfield, Herkimer county.

Holopea antiqua, var. pervetusta.

PLATE LIV. FIG. 4 & 5.

Among the specimens figured by Mr. CONRAD under the name *Littorina pervetusta*, I find those referred to on Plate LIV as above. I have given the figures as they are drawn, one representing a cast and the other the shell. In the latter the columella is represented as slightly reflexed, but the umbilical groove is scarcely perceptible.

This one may be a distinct species; but as the *H. antiqua* presents considerable variety of form in the casts which have come under my observation, I prefer, for the present, to consider it a variety of that species.

The specimens figured are from the Tentaculite limestone, but the particular locality is not mentioned by Mr. CONRAD.

Holopea danai (n. s.).

PLATE LIV. FIG. 14.

SHELL ovoid-conical, the spire tapering abruptly: volutions about five, convex, the last one extremely ventricose and equalling in height the remaining ones: suture, in the cast, deeply impressed, and the upper margins of the volutions truncate. Surface unknown.

The cast retains something more than three volutions, and there appear to have been two more at the apex.

This species differs from the preceding in the more rapid diminution of the spire above the last volution, and in the truncated upper edges of the volutions. It bears some general resemblance to *H. paludinæformis* of the Trenton limestone, but the spire is longer and more conical.

Fig. 14. Anterior view of the cast of this species.

Geological position and locality. In the pentamerus limestone at Chittenango falls.

Holopea? elongata (n. s.).

PLATE LIV. FIG. 6 & 7.

SHELL elongate, subfusiform: spire very gradually tapering; volutions about five or six, regularly rounded, the last one moderately ventricose; columellar lip slightly thickened and reflexed. Surface unknown.

Specimens of this species are numerous on the worn surfaces of some beds of the upper part of the Tentaculite limestone near its junction with the Pentamerus limestone, and in the latter rock, often associated with *H. antiqua*. The species is readily recognized among all others of this group, by its general form.

Fig. 6. A section of a small individual shown on the worn surface of the rock.

Fig. 7. A larger specimen which preserves some remains of the columellar lip, the upper volutions being entire.

Geological position and locality. In the tentaculite and pentamerus limestones: Helderberg mountains, Schoharie, Carlisle, Manlius, and other places.

Loxonema attenuata (n. s.).

PLATE LIV. FIG. 8; and PLATE LXVII. FIG. 3.

SHELL fusiform, somewhat rapidly attenuating above the last volution, which is ventricose : aperture undetermined. Surface unknown.

The specimens figured are casts, one preserving four volutions and the other eight.

Fig. 8. The posterior side of the cast, the aperture being filled with stone.

PLATE LXVII. Fig. 3. A cast of the interior, preserving eight volutions.

Geological position and locality. In the upper part of the shaly limestone, Herkimer county; and in the upper pentamerus limestone, Carlisle, Schoharie county.

Loxonema fitchi (n. s.).

PLATE LIV. FIG. 9, 11 *a* & 11 *b*.

SHELL subfusiform, very gradually attenuate : volutions seven or eight (six preserved in the imperfect specimen). Surface unknown.

The specimen fig. 9 is a cast, which is flattened so that the volutions, as presented in the figure, give the shell a greater proportional width than the natural form. It is much more gradually attenuate than the preceding species, the last volution is less ventricose, and the entire shell has been considerably longer.

Fig. 9. Anterior side of a cast which is flattened in that direction.

Fig. 11 *a*. A fragment of the same species from the shaly limestone.

Fig. 11 *b*. A similar fragment of a larger individual.

Geological position and locality. In the shaly limestone : Carlisle, Schoharie county; and Helderberg mountains, Albany county.

Loxonema? obtusa (n. s.).

PLATE LIV. FIG. 10.

SHELL elongate, terete, very gradually tapering, subobtuse at the apex: volutions about nine or ten, eight of which are preserved in the specimen, gently rounded on the exterior and very gradually diminishing in size, the last one being little more ventricose than the one above it. Aperture and surface unknown.

Fig. 10. A longitudinal section of a specimen of this species upon the worn surface of the rock.

Geological position and locality. In the pentamerus limestone; Schoharie.

Loxonema? compacta (n. s.).

PLATE LIV. FIG. 12.

SHELL elongate, fusiform, very gently tapering in the lower part, and more rapidly towards the apex: spiral very gradually ascending; volutions, thirteen of which are preserved in the specimen, gradually increasing in size from the apex, the last one scarcely more ventricose than the next above, regularly convex upon the exterior, each one about twice and a half as wide as high. Surface unknown.

The specimen is a cast which preserves no surface markings. The last volution preserved may not have been the terminal one.

This species resembles the *L. obtusa;* but the volutions are proportionally smaller and more closely arranged, there being in this one more than eight in the space of six of that species.

Fig. 12. A specimen from which the shell is exfoliated, preserving thirteen volutions with the apex imperfect.

Geological position and locality. In the lower beds of the pentamerus limestone: Schoharie county.

Loxonema planogyrata (n. s.).

PLATE LIV. FIG. 13.

SHELL extremely elongate, very gradually and evenly tapering to the apex : volutions twelve or thirteen (of which ten are preserved in the specimen), about twice as wide as high, gradually ascending, depressed convex on the exterior or a little flattened on the upper side of the lower volutions, the last one scarcely ventricose, with a slight indication of an obtuse carina towards the base. Surface unknown.

The specimen figured is the only one seen. The upper volutions are broken off or obliterated, and the aperture is imbedded in the stone. It may be recognized by its long and slightly convex volutions, the last one of which is nearly flat on its longitudinal slope.

Fig. 13. The anterior side of the specimen, the apex of which, as represented in the figure, preserves no marks of volutions.

Geological position and locality. In the pentamerus limestone : Schoharie county.

Murchisonia extenuata (n. s.).

PLATE LIV. FIG. 15 & 16?

SHELL elongate, attenuate : volutions uniangular ; aperture round-ovoid. Surface unknown.

Fig. 15 is copied from a figure of Mr. CONRAD, which is cited as from the Tentaculite limestone of Fayetteville, Onondaga county.

Fig. 16 is a much worn specimen, which is perhaps of the same species.

Geological position and locality. In the tentaculite limestone of Schoharie and Onondaga counties.

Murchisonia minuta (n. s.).

PLATE LIV. FIG. 17.

SHELL minute : spire elongate, gradually attenuate ; volutions about nine or more, rounded, bicarinate. Aperture and surface unknown.

Figures 17 are representations of the specimen, natural size and enlarged, from figures by Mr. CONRAD*.

Geological position and locality. In the tentaculite limestone : Fayetteville, Onondaga county.

* When these and some other figures of Mr. CONRAD were copied on Plate LIV. I had hoped to be able to procure the specimens for final description, from the cabinet of the late Mr. VANUXEM. The sale of this collection, and its removal to Tennessee, has prevented the fulfilment of this intention.

Murchisonia bilirata (n. s.).

PLATE LV. FIG. 2.

The specimen is a fragment preserving two volutions, the margins of which are marked by a fine elevated line on each side of the central spiral band, and parallel with it. The surface is finely striated.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Albany county.

PLATYOSTOMA.

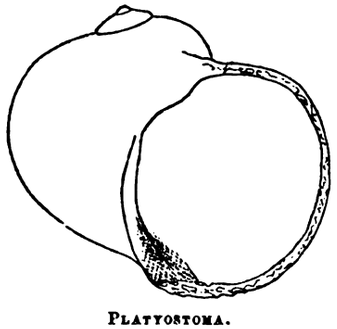
The Platyostomæ of CONRAD are globose shells with low spires, having columella : the last volution is extremely expanded, the aperture very large, and the columellar lip thickened.

The following is the description of the Genus PLATYOSTOMA, as given by Mr. CONRAD in the Journal of the Academy of Natural Sciences, Vol. viii, p. 275 :

"**PLATYOSTOMA**, CONRAD.

"SHELL subglobose : spire short; aperture very large, suborbicular, dilated; labrum "joining the body whorl at right angles to the axis of the shell."

These shells are often distorted by pressure to a great extent, and it is not possible always to distinguish the casts of this genus from those of the STROPHOSTYLUS, or from those of some species of the PLATYCERAS of CONRAD.



PLATYOSTOMA.

The *P. ventricosa* is given as the type of the genus, and the accompanying figure is copied from the outline of the shell as given by Mr. CONRAD on Plate XVII of the volume cited.

Platyostoma ventricosa.

PLATE LV. FIG. 9 *a*, *b*, *c*, *d*.

Platyostoma ventricosa : CONRAD, Jour. Acad. Nat. Sciences of Philadelphia, 1842, Vol. viii, pa. 275, pl. 17, f. 5.

"Globose : whorls somewhat scalariform, or flattened above; lower part "of columella prominent; labrum reflected; width and length of "aperture nearly equal."

The specimens before me vary from globose to depressed-globose, and obliquely ovoid; due perhaps in part to the original form of the shell, and more to the subsequent accidental causes. After comparing a large number of specimens, I do not find any constant or satisfactory character for the reliable separation of those occurring in the Oriskany sandstone, from those in the Lower Helderberg group, which seem to me referable to this species of MR. CONRAD.

The *Platyostoma arenosa* of CONRAD (Trans. Acad. Nat. Sciences of Philadelphia, Vol. viii, pa. 276, pl. 17, f. 6) appears to me to be only the young of *P. ventricosa*. Some of the specimens from the Oriskany sandstone, of the same dimensions as the figure cited, do not differ from that one; while there are numerous intermediate forms, which, in the casts, cannot be satisfactorily distinguished.

As this fossil appears in its various forms, it may be described as Globose, more or less depressed or obliquely subovoid : spire moderately elevated, consisting of three or four volutions, the last one of which is extremely ventricose; volutions flattened upon the upper side; aperture circular or subovate; columellar lip reflexed. Surface marked by fine closely arranged striæ.

Fig. 9 *a*. View of a depressed-globose specimen, from which the shell is nearly removed.
Fig. 9 *b*. View of the aperture of the same. [This figure is not properly given.]
Fig. 9 *c*. A globose specimen which preserves a fragment of the shell.
Fig. 9 *d*. A worn specimen, showing a longitudinal section of the shell on one side of the centre.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Catskill, and Becraft's mountain.

Platyostoma arenosa.

PLATE LVII. FIG. 3 *a*, *b*.

Platyostoma arenosa : CONRAD, Jour. Acad. Nat. Sciences of Philadelphia, 1842, Vol. viii, pa. 276, pl. 17, f. 6.

"Obliquely ovate-globose : body-whorl rapidly widening to the base; "aperture longitudinally suboval."

The above description of Mr. CONRAD corresponds with the characteristics of this and other specimens in my collections, which, however, appear to me as the young of *P. ventricosa*. As the specimens are mostly casts, or only preserving the shell in a very imperfect condition, it is impossible to determine this question at the present time with entire satisfaction.

Fig. 3 *a*. View looking upon the spire. Fig. 3 *b*. View of the aperture of the same.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Near Catskill.

There are, besides the true PLATYOSTOMÆ, some other shells of not very dissimilar character in the rocks of this age. Some of these, in the casts and in their exterior conformation, are remarkable for their oblique form and the wide-spreading of the last volution, which is also often exaggerated by pressure in the same direction.

These fossils have sometimes the globose form of PLATYOSTOMA; but in these instances they are usually more symmetrical, and may be recognized by the smoothly rounded outline and the extreme posterior extension of the outer lip on the adjacent volution. The surface is evenly striated by fine elevated threadlike striæ parallel to the lines of growth.

Although differing in external characters from any other gasteropods of the group, I have not until recently had the means of determining the generic relations of these forms. During the past year (1857) I obtained from Mr. ANDREWS of Cumberland, Maryland, some Gasteropoda of the Oriskany sandstone, among which was a single specimen of one of these shells entire and without adhering stone. This specimen, and some others

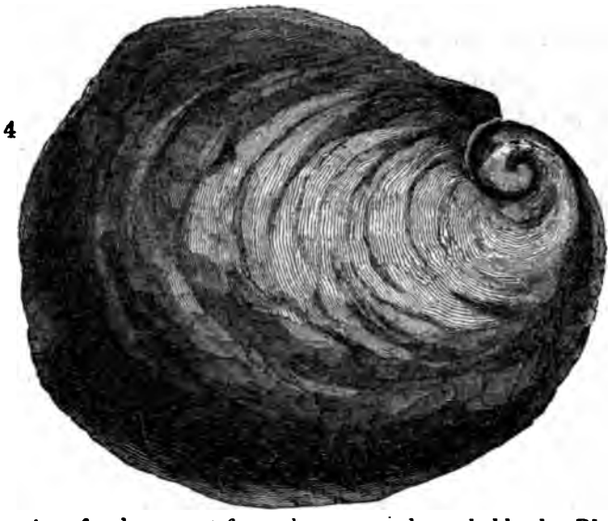


Fig. 4. The exterior of a large cast from the same rock, probably the *Platyceras expansus* of CONRAD (Annual Report of 1841, p. 56).

In the earlier progress of this volume, the specimens figured on Plate LXVII, from the Upper Pentamerus limestone, were the only ones known to me in the Lower Helderberg group. Subsequently two or three species have been obtained from Becraft's mountain, one of which is figured on Plate LV.

Strophostylus elegans (n. s.).

PLATE LV. FIG. 1 *a*, *b*, *c*, *d*.

SHELL obliquely ovoid. Spire short, very neatly tapering to a minute apex: volutions about four, symmetrically rounded on the exterior surface; suture neatly defined, the last volution ventricose, the upper or right margin of the lip much extended upon the side of the volution: aperture obliquely oval or ovoid. Surface marked by fine equal curving striæ.

The aperture has not been observed in this species; but from its general form and surface markings, I can have no doubt that its proper place is among the species of this genus.

Fig. 1 *a*. A small specimen which is imbedded in limestone. Fig. 1 *b*. A larger individual.
Fig. 1 *c*. A larger specimen, the surface better preserved.
Fig. 1 *d*. An enlarged figure, showing more distinctly the fine striæ and form of the shell.

Geological position and locality. In the compact beds of the shaly limestone: Helderberg mountains, Schoharie, and Becraft's mountain near Hudson.

Strophostylus globosus (n. s.).

PLATE LV. FIG. 8.

SHELL globose. Spire short, obtuse : volutions three or four, rounded exteriorly, rapidly increasing in size, the last one symmetrically rounded and very ventricose, the upper margin of the lip extended at its junction with the volution; aperture subcircular; suture distinctly canaliculate.

SURFACE marked by extremely fine threadlike undulating striæ, and, in older shells, by faint revolving undulations.

This species differs conspicuously from the *S. elegans* in its more depressed spire and more rotund form, as well as in the canaliculate suture and finer striæ. The revolving undulations are too undefined to become a character of importance, unless in better preserved specimens than I possess : they are visible from reflection, on turning the specimen in the light.

Fig. 8. A cast of the species, preserving a fragment of the shell along the suture.

Since this plate was engraved, I have obtained specimens of this fossil, with the shell entire, from Becraft's mountain, through the kindness of Mr. WARDLE, formerly of Stockport, Columbia county.

Geological position and locality. In the shaly limestone of the Lower Helderberg group, and in the compact beds of the same formation : Becraft's mountain and Catskill.

Strophostylus obtusus (n. s.).

PLATE LXVII. FIG. 1 *a*, *b*.

SHELL subglobose; height a little greater than the width. Spire short obtuse, nearly flat above the second volution : volutions about four, very rapidly increasing in size, becoming very ventricose below the second one, and swelling out laterally; suture canaliculate, with a distinct ridge just outside the groove, from which the surface slopes abruptly to the general curvature of the volution : aperture round-ovate, contracted behind by the upper edge of the peristome, joining the volution below the middle.

SURFACE finely striated : striæ making a slight curvature on the sutural carina.

This species differs conspicuously from the preceding, in its very abruptly terminated spire, and the greater lateral extension of the volutions compared with the height; in the obtuse carina just outside the suture, and in the form of the aperture, which is peculiar.

The specimen is filled with stone; and it is only the broken edge of the columella that can be seen, and which is imperfectly represented in the figure.

Fig. 1 *a*. View showing the aperture with the obtuse spire, which is barely visible above the second volution.

Fig. 1 *b*. View looking upon the spire.

Geological position and locality. In the upper pentamerus limestone: Helderberg mountains.

Strophostylus depressus (n. s.).

SHELL depressed-globose; height less than the width. Spire flat, or scarcely elevated above the outer volution : volutions three or four, the last one ventricose and greatly expanded laterally; suture concave, the outer volution declining from near the middle of its upper side to the suture-line : aperture transverse.

SURFACE marked by transverse undulations and scarcely visible striæ, which are cancellated by fine revolving striæ.

The specimen examined is somewhat imperfect, but presents characters quite distinct from either of the others, in its proportions and in the revolving striæ. The columella, though broken, has the character of others of the genus, as far as can be observed.

Geological position and locality. In the compact layers of the shaly limestone : Becraft's mountain.

Strophostylus fitchi (n. s.).

PLATE LXVII. FIG. 2 *a* – *c*.

SHELL depressed, somewhat semiglobose. Spire short, scarcely elevated, consisting of three or four volutions, the last one becoming extremely

CAPULUS, PILEOPSIS, ACROCULIA, and PLATYCERAS.

IN the work entitled "Figures and Descriptions of the Palæozoic Fossils of Cornwal, Devon and West-Somerset," by Professor PHILLIPS, published in 1841, he has proposed the Genus ACROCULIA to include certain fossils which had been referred to the Genus PILEOPSIS, and to which, he remarks, they "offer but slight analogy." His description is as follows:

"*Provisional character.* Obliquely spiral; the apex free, the aperture "ample, without columella: a sinus in the right lip."

This generic distinction has been acknowledged by some palæontologists; but, more recently, both Continental and English naturalists have referred all these forms to CAPULUS or PILEOPSIS, which are regarded as synonymous.

Previous to the publication of the work of Professor PHILLIPS cited above, Mr. CONRAD, in his Report on the Palæontology of New-York for 1840 (p. 205), proposed the generic name PLATYCERAS, with the following remarks:

"I propose to group in this genus the *Pileopsis tubifer* (SOWERBY), *P. vetusta* "(SOWERBY), the *Nerita haleotis* (SOWERBY), and perhaps *Bellerophon cornuarietes*. "The shells are suboval or subglobose, with a small spire, the whorls of which are "sometimes free and sometimes contiguous: the mouth is generally campanulate "or expanded. I have not seen a species above the Silurian rocks, though they "probably occur above them in Europe*, and they are never found in the Lower "Silurian strata: they characterize the middle portion of the system."

The generic description of Mr. CONRAD is more comprehensive than that of Professor PHILLIPS, as it includes shells with the volutions free or contiguous. Both authors, however, have designated among the typical

* At the time this was written, the Hamilton and Chemung groups were regarded as a part of the Silurian system by the New-York geologists, the Hamilton group being recognized as the equivalent of the Ludlow rocks of England; and we have yet seen no sufficient reasons to regard it otherwise. Mr. CONRAD, in including the *Bellerophon cornuarietes* in the Genus PLATYCERAS, must have regarded it as an unsymmetrical shell.

forms the *Pileopsis vetusta* of SOWERBY. The species first described by Mr. CONRAD are the *P. dumosum* of the Upper Helderberg limestone, the *P. ventricosum* and *P. gebhardii* from the Lower Helderberg; the two latter species being figured on Plate LVII and other plates of this volume. In these species the volutions are few, but contiguous; and the shells occur with a broad expansion of the lip, or terminate in a thin unexpanded margin. The *P. dumosum* is spiniferous. Some of the species subsequently referred by Mr. CONRAD to this genus have the lower volutions free, and consisting of a single turn at the apex of the shell.

The species which I have grouped under this genus present a great variety of forms, and it might be questioned whether there may not be reason for a farther separation; but the variations presented in the same species, when examined in a large number of individuals, render it sometimes difficult to draw the line of specific distinction.

GENUS PLATYCERAS (CONRAD, as emended).

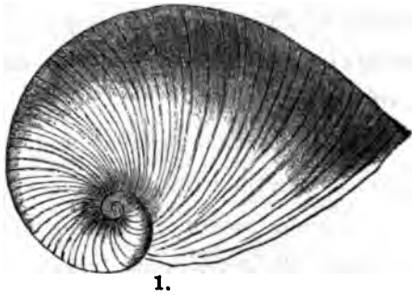
SHELLS depressed subglobose, subovoid or obliquely subconical. Spire small: volutions few, sometimes free and sometimes contiguous, without columella; aperture more or less expanded, often campanulate and sometimes with the lip reflexed; peristome entire or sinuous.

SURFACE striated or cancellated, often spirally ridged or plicate and sometimes strongly lamellose transversely, nodose or spiniferous.

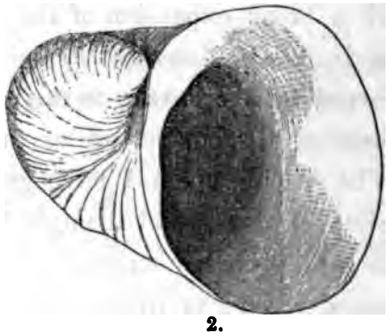
Many of the species show a sinuosity of the striæ, indicating a notch in the margin of the aperture during the first stages of growth, and this notch sometimes remains in the mature condition. More frequently, however, the earlier sinus is closed, and, in certain species, the margin continues unbroken, while in a few others this sinus is continued to the margin at the final period of growth; but more often it becomes closed at some period during the growth of the shell, and another commenced at some other point; and not seldom two or more are thus begun and continued, while some simply striated species, with a single sinus in

their earlier stages of growth, become more or less plicated towards the margin, with several sinuosities in the peristome at the mature condition: usually, however, one or two of the marginal sinuosities are deeper than the others.

Platyceras ventricosum.



1.



2.

The spine-bearing forms begin their existence in the Oriskany sandstone, are more abundant in the Upper Helderberg limestone, and one or two are known in the Hamilton group. There are likewise a few spine-bearing forms in the Carboniferous limestone of the West.

3.

PLATYCERAS TRILOBATUM.

4.

PLATYCERAS BISULCATUM.

5.

PLATYCERAS INTERMEDIUM.

The species which present themselves in this group of strata, and in the succeeding Upper Helderberg rocks, may be conveniently divided into two or three groups, presenting certain general characters by which they can be distinguished. These distinctions, however, are perhaps not sustained in the more intimate relations of the shells.

In the grouping of the species in their succession in the several plates, I have endeavored to bring together in some degree the forms more nearly related; beginning with those resembling PLATYOSTOMA in form, and progressing to the opposite extreme with as much regard to systematic arrangement as was possible under the circumstances in which the materials were collected, and the long intervals which elapsed between the completion of the earlier and the later parts of this portion of the work, and with constantly increasing collections.

Platyceras ventricosum.

PLATE LVI. FIG. 1 – 4 & 8; and PLATE LVII. FIG. 4.

Platyceras ventricosum : CONRAD, Annual Report on the Palæontology of New-York, 1840, p. 206.

"SHELL ventricose : aperture very large and campanulate; volutions "three, contiguous, depressed below the upper margin of the whorl."

The shell is obliquely ovate, spreading rapidly from the apex, and becoming extremely ventricose below; aperture campanulate, the lip in contact with the spire, and sometimes strongly reflexed.

SURFACE marked by fine transverse or concentric lamellose striæ, which are somewhat undulated and rarely finely cancellated by faint revolving striæ.

This species is a comparatively common form in the upper part of the Shaly limestone, its usual size being that of the specimens figured on Plate LVI; rarely equalling the size of fig. 4, Plate LVII; while I have one specimen which measures, from the anterior margin of the aperture across the volutions to the posterior side, more than three inches.

PLATE LVI.

Fig. 1 *a*, *b*. Views of the upper and lower side of a young specimen which is a cast.

Fig. 2 *a*. View of a specimen of medium size, looking upon the top of the spire.

Fig. 2 *b*. View of the aperture of the same, showing also that the spire is not as high as the outer volution.

Fig. 3 *a*. View of the spire of a larger specimen : the last volutions are obscured. The surface preserves a few obscure wrinkles.

Fig. 3 *b*. Aperture of the same.

Fig. 4. The specimen is a partial cast, preserving a small portion of the shell, and showing very distinctly the volutions of the spire.

Fig. 8. A cast of the same species.

PLATE LVII.

Fig. 4. A large individual which is extremely ventricose. The specimen is silicified, and the surface striæ are obliterated.

Fig. 2, Plate LXI, is possibly a specimen of this species.

Geological position and locality. In the Shaly limestone, and in the compact layers of the same rock : Helderberg mountains, Schoharie, Catskill, Becraft's mountain, etc.

Platyceras gebhardi.

PLATE LVI. FIG. 5 *a b*, 6, 7 & 9; and PLATE LV. FIG. 6 *a b*.

Platyceras gebhardi : CONRAD, Annual Report of 1840, p. 206.

"Differs from the last in having a much larger and more prominent "spire, which is longitudinally carinated near the apex, and with distinct "transverse undulated striæ."

SHELL obliquely subovate or subglobose, somewhat gradually expanding, and becoming ventricose in the last volution. Spire composed of about four volutions, which are contiguous except the last one near the aperture, the apex being nearly in the plane of the outer volution : aperture expanded, campanulate, and sometimes with the lip reflexed.

SURFACE marked by fine transverse undulating striæ, which are sometimes distinctly bent backwards along a line near the dorso-lateral curvature of the shell, or nearer to the middle of the summit, and rarely slightly carinated along this line. In a few specimens, distinct revolving striæ are seen cancellating the transverse striæ.

This species is distinguished from the last by expanding less rapidly, and being less ventricose; the apex of the spire never so far below the plane of the outer volution, being sometimes slightly below, on the same plane, or elevated a little above the outer volution : the suture line is deeply impressed, but not canaliculate. The carination mentioned by Mr. CONRAD has been observed only in the specimen which he had under examination; though a similar bending backwards of the striæ is noticed on other specimens, indicating a notch in the labrum, which appears to have been more conspicuous in the young shells than in the mature specimens.

PLATE LVI.

Fig. 5 *a*. View of the spire of a specimen of ordinary size. The striæ are not sufficiently undulated in the drawing.

Fig. 5 *b*. Profile of the same from the back of the shell.

Fig. 6. The spire of another specimen where the last volution is more free near the aperture, and slightly carinated near the apex.

Fig. 7. The cast of a specimen of this species.

Fig. 9. A similar cast, the last volution becoming free.

PLATE LV.

Fig. 6 *a*. An enlargement of the spire of the specimen fig. 5, Plate LVI; showing the carination along the summit, and the abrupt bending of the striæ.

Fig. 6 *b*. A still farther enlargement, showing the fine revolving striæ which cancellate the coarser transverse striæ, and the proportionate size of the two sets. In another specimen, this carinated line and abrupt bending of the striæ has been traced nearly to the aperture, where it suddenly ceases, and the shell is without sinus on its margin.

For farther observations on this and the preceding species, see remarks under head of Oriskany sandstone.

Geological position and locality. In the upper part of the Shaly limestone, and in the compact layers of the same : Helderberg mountains, Schoharie, Carlisle, Catskill and Becraft's mountain.

Platyceras robustum (n. s.).

PLATE LV. FIG. 10 & 11 *a*, *b*.

SHELL robust, somewhat ovoid, very slightly oblique, gradually expanding towards the aperture which is campanulate, and transversely broad-oval : volutions about three, the inner ones small; the outer volution thick and strong, somewhat regularly rounded.

SURFACE marked by undulating lamellose striæ, which are in some parts crowded into elevated folds or wrinkles, with a distinct double sinuosity on the right side of the aperture, and a broader one on the left or umbilical side. Fine revolving striæ are sometimes observed cancellating the transverse striæ.

This species presents a general similarity to *P. ventricosum* in the depression of the first volutions of the spire below the plane of the outer ones, but the specimens are never so rapidly expanding or ventricose; and the last volution, at its junction with the labrum, is, in this species, much broader and stronger; while the volutions

in that one are more oblique, and never so nearly in the same plane, but the aperture is more nearly round.

These differences are very perceptible in a comparison of the figures on Plates LV and LVI. The peculiarities of form may serve to distinguish the casts of the two species, while the undulating striæ of the one under consideration will distinguish them by the surface characters.

Fig. 10. View of the spire of a large individual, showing the undulating striæ and the sinuosities of the right side of the aperture.

Fig. 11 *a*. View of the aperture of a smaller specimen, which is a cast.

Fig. 11 *b*. View of the aperture of a similar specimen.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Albany and Schoharie counties.

Platyceras sinuatum (n. s.).

PLATE LV. FIG. 5 & 7; and PLATE LVII. FIG. 2.

SHELL depressed, somewhat obliquely ovoid : volutions about three, contiguous, the last one becoming very ventricose, a little flattened on the upper side, and expanded laterally to the axis of the spire : aperture broad campanulate; margin deeply sinuate.

SURFACE marked by fine concentric or transverse lamellose striæ, and stronger wrinkles or folds. The striæ are abruptly bent backwards on the upper dorsal side, and a deep sinus marks the labrum : the lower side of the aperture is likewise deeply sinuate.

The specimen fig. 5 is vertically compressed on the outer margin of the last volution and towards the aperture, leaving its inner margin a little elevated, and the inner volutions a little below the plane of the last volution. The other specimen, referred with doubt to this species, is distorted by pressure, and the upper volutions of the spire are a little above the plane of the outer volution. The sinuosity in the smaller specimen is wide and well defined : in the larger one it has, in the young state, been similar to the other, but has become a narrow slit towards the aperture. A similar change takes place in other species as they advance in age, till the notch is finally entirely closed.

Fig. 5. View looking upon the spire of a small specimen, showing the deep marginal sinuosity and the strongly wrinkled surface.

Fig. 7. A dorsal view of a larger individual which is compressed upon the outer volution, showing the narrow linear sinus near the aperture, which, from the bending of the striæ nearer the apex, must have been wider at that period of growth.
This shell has, in a great degree, the character of a PLEUROTOMARIA, but, as far as can be determined, is destitute of a columella.

PLATE LVII. Fig. 2. View of the spire of a specimen of the same species.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains, Schoharie, Becraft's mountain, etc.

Platyceras billingsi (n. s.).

PLATE LVII. FIG. 1 *a*, *b*.

SHELL subglobose, gradually and uniformly enlarging from the apex to the third volution, below which it is abruptly expanded, becoming very ventricose; the aperture nearly circular, campanulate. Spire elevated above the plane of the outer volution.

SURFACE marked by fine lamellose striæ, which, on the lower part of the shell, are even and scarcely undulating; while the upper part of the shell is subcarinate, and the striæ are abruptly undulated.

This species is very peculiar in its contour and in its surface markings. The first three volutions present, on the upper side towards the apex, several obtuse undefined angles which are resolved into a single one below, over which the striæ bend very abruptly backwards, indicating a deep and wide sinuosity at this stage of growth. At this point the volution suddenly expands; and the surface of the specimen being here broken, the gradual obliteration of the sinus is not traceable; but on the lower half of the last volution, the striæ are simple, and with no perceptible undulation marking the place of the original marginal sinus. There is, likewise, on the umbilical side, a sharply defined sinus on the first volutions.

In a species of this kind, the earlier stages of growth give no evidence of the mature form of the shell; and it must be admitted that determinations of species in this genus, where founded on one or two specimens without a knowledge of the changes which it may undergo in the different stages of growth, are liable to error.

Fig. 1 *a*. View of the aperture of this species. [The striæ on the lower side of the figure are very incorrectly represented.]

Fig. 1 *b*. View looking upon the spire of the same specimen, the upper part of which shows the subangular form and the sinuosity of the striæ.

Fig. 1 *c*. For description, see *Strophostylus rotundatus*.

Geological position and locality. In the upper part of the shaly limestone : Becraft's mountain.

Platyceras trilobatum (n. s.).

PLATE LVII. FIG. 5 *a*, *b*, *c*.

BODY of the shell obliquely or arcuately ovoid, trilobate : volutions three or four, the last one (or more) becoming free, gradually expanding to the aperture; the apex closely involved and rising above the plane of the outer volution, or sometimes on the same plane, concave towards the suture : aperture subangularly ovate, sinuate on the right and left sides, and the shell extended in front.

SURFACE marked by two strong spiral depressions corresponding to the sinuosities of the aperture, and crossed by lamellose striæ which are strongly undulated on the sinuosities of the last volution, and are marked by other undulations on the earlier volutions, indicating former sinuosities in the margin of the aperture.

The characters here given are well marked in several individuals, presenting a contracted trilobate aspect, from the two sinuosities which extend in strong depressions or grooves from the aperture to beyond the commencement of the first volution.

Fig. 5 *a*. View of the aperture and part of the spire of a large individual. [The striæ represented between the aperture and the next volution do not exist in the specimen.]

Fig. 5 *b*. The lower or umbilical side of the same specimen, showing the sinus on that side.

Fig. 5 *c*. The upper side of the specimen, showing the sinuosity on that side and the extension of the shell in the middle. The upper volutions are imperfect.

Geological position and locality. In the upper part of the shaly limestone of the Lower Helderberg group : Becraft's mountain and Schoharie.

For descriptions of figures 6 *a* and 6 *b* of Plate LVII, see under PLEUROTOMARIA.

Platyceras unisulcatum (n. s.).

SHELL depressed-globose or subdiscoid. Spire nearly on the same plane : volutions about three, somewhat gradually expanding, the last one ventricose, somewhat flattened on the dorsal side; aperture campanulate, entire on the right side and sinuate on the left side.

SURFACE marked by lamellose concentric striæ, which are broadly undulated and bending backwards on the upper side of the volution and forwards on the middle or dorsal side, while they are bent abruptly backwards on the lower side, and the line marked by a strong groove.

This species resembles the *P. gebhardi*, but is larger than that species usually occurs, is flattened upon the back and canaliculate beneath; characters not observed in that species. Diameter from anterior of mouth across the spire, nearly two and a half inches.

Geological position and locality. In the compact layers of the upper part of the shaly limestone : Becraft's mountain.

Platyceras tenuiliratum (n. s.).

PLATE LVIII. FIG. 1 – 5; and PLATE LIX. FIG. 6 *a*, *b*.

SHELL small, depressed, subovoid or subdiscoid, with the last volution very ventricose. Spire slightly raised above the plane of the outer volutions: volutions about three, the first and second very minute, and the last one rapidly expanding; aperture campanulate, with the lip broadly reflexed on the posterior and part of the right side.

SURFACE marked by fine threadlike striæ, which often become lamellose on the last volution, and these are cancellated by very fine revolving striæ.

The direction of the striæ show that, in the earlier stages of growth, there was a sinus near the centre of the anterior side of the aperture. In the progress of growth this has been filled up, and another commenced nearer the spire, and also one on the left side near the umbilicus, both of which are continued to the maturity of the shell. The lower sinus is sometimes developed at an early stage of growth.

PLATE LVIII.

Fig. 1. A young shell where the second sinus is not developed.

Fig. 2 *a*. A specimen where the second sinus has begun to be developed.

Fig. 2 *b*. View of the aperture and umbilicus of the same. The expanded peristome is broken off, except a small portion adjacent to the volution.

Fig. 3 *a*. Profile of a specimen which is more coarsely striated than usual.

Fig. 3 *b*. Spire of the same.

Fig. 3 *c*. Enlargement of the surface of this specimen, showing the transverse and longitudinal striæ.

Fig. 4 *a*. View of the spire of an individual where the peristome has been much expanded on the side of the volutions.

Fig. 4 *b*. Lower side of the same, showing the umbilicus. (The peristome has originally extended much farther, so as nearly to cover the umbilicus.)

Fig. 5 *a*. A large individual of this species, showing the broad shallow sinus in the peristome.

Fig. 5 *b*. View of the same, showing the sinus on the lower side of the shell.

Fig. 5 *c*. An enlargement of the surface near the aperture, where the transverse striæ have become lamellose.

PLATE LIX.

Fig. 6 *a*, *b*. The specimen may be a compressed form of this species.

Geological position and locality. In the middle portions of the Lower Helderberg group, associated with numerous species of Brachiopoda : Albany and Schoharie counties.

Platyceras bisinuatum (n. s.).

PLATE LVIII. FIG. 6 *a*, *b*.

SHELL small, obliquely subconical, arcuate, with a little more than a single contiguous volution at the apex; the two first volutions rounded, somewhat symmetrical when the dorsal portion becomes prominent, and marked on each side by a narrow sinus; while still later another is developed on the right side, and which continues to the present margin.

SURFACE marked by fine lamellose transverse striæ and obscure longitudinal or revolving striæ, and two strongly marked spiral grooves bounding a dorsal lobe.

Having but a single specimen of this species, its characters may not be fully represented; but it appears so different from any other in the collection, as to leave no doubt of its specific distinctness.

Fig. 6 *a*. The upper side of the spire, showing the sinus in the peristome, and the sinus bordering the dorsal lobe : the extension of the latter, being broken off, prevents the appearance of the notch in the peristome at this point.

Fig. 6 *b*. The lower side, showing the sinus on the lower side of the dorsal lobe. The notch in the peristome is exaggerated by the broken condition of the shell.

Geological position and locality. In the middle portions of the shaly limestone, associated with *Orthis* and *Spirifer*, at the base of the Helderberg mountains, Albany county.

Platyceras pentalobus (n. s.).

PLATE LVIII. FIG. 7 *a*, *b*, *c*.

SHELL obliquely subconical : spiral with about two volutions; apex and upper volution smooth and rounded, becoming plicate on the last volution; plications four, five or more; peristome simple.

SURFACE marked by fine transverse striæ, which are strongly undulated in passing over the plications.

I have not been able to trace this species through its gradations of form; but it is so different from the other species observed, that I can have no doubt of its specific distinctness.

Fig. 7 *a*. View of the spire and the plications of the surface.
Fig. 7 *b*. View of the aperture and lower part of the spire.
Fig. 7 *c*. Profile or dorsal view.

Geological position and locality. In the central portion of the Lower Helderberg group : Base of the Helderberg mountains, Albany county.

Platyceras multisinuatum (n. s.).

PLATE LVIII. FIG. 8 *a*, *b*, *c*, & 9 *a*, *b*.

SHELL subdiscoid in the young state; apex nearly on a plane with the outer volution : volutions about three, the first ones minute; outer one becoming free, ventricose, rounded or scarcely angular below, somewhat flattened on the upper side, marked by several ridges and shallow depressions on the upper and dorsal side : aperture somewhat longitudinally oval; peristome sinuate, with a deeper sinuosity on the anterior margin.

SURFACE marked by fine transverse striæ, which are strongly undulated on the inequalities of the shell, and crossed by fine longitudinal or revolving striæ.

This is a very distinct and pretty species, which, in its younger condition, shows all the volutions contiguous; but as it advances, the outer one continues in a direct line, and, expanding more rapidly, the shell loses its subdiscoid character as in fig. 9 *a*. The plications become more strongly developed and more numerous as the shell grows older : at the same time, by the increase of the outer volution, the apex of the spire becomes depressed below its plane.

Fig. 8 *a*. View of the aperture and lower side of the shell (which is represented as too smooth in the figure, from a little adhering stone).

Fig. 8 *b*. View of the spire and upper side of the volutions, showing the folds or carina.

Fig. 8 *c*. An oblique view, showing the sinuosity in the anterior margin of the aperture.

Fig. 9 *a*. An older specimen in which the inequalities from the upper part of the last volution are worn off, the plications being more strongly marked on the peristome.

Fig. 9 *b*. Dorsal or profile view, showing the outer volution above the apex of the spire. The deep sinus in the anterior margin of the younger shell is not conspicuous in this one, the peristome having become strongly and almost regularly plicate, except on the posterior side, where there is a broad shallow sinus.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Albany and Schoharie counties.

Platyceras retrorsum (n. s.).

PLATE LVIII. FIG. 10 *a b*, & 6 *c*; and PLATE LIX. FIG. 9 *a*, *b*.

SHELL spiral; the apex above, or on the same plane with the outer volution : volutions about two, the first one nearly smooth, gradually becoming spirally angulate or plicate upon the surface; upper side flattened, the lower side rounded : aperture somewhat round; peristome sinuate.

SURFACE marked by fine crowded transverse striæ which are extremely sinuate, the sinuosities varying at different stages of growth, crossed by fine revolving striæ.

This species resembles the preceding in some respects; but in three specimens examined, the volutions are free, the shell a little more robust, and some of the angles more sharply defined. One specimen, which may be a variety of the same species, is less angular, more extended on the umbilical side, and has the apex of the spire below the plane of the outer volution.

Fig. 10 *a*. The upper side of the spire, from which the shell is worn smooth and partially removed.

Fig. 10 *b*. Profile view, showing the dorsal side and the elevated apex of the spire.

Fig. 6 *c*. An imperfect specimen, which may be the young of the same.

PLATE LIX. Fig. 9 *a*, *b*. A specimen which is probably of this species. The specimen figured is broken at the apex, and somewhat otherwise distorted.

Geological position and locality. In the shaly limestone of the Lower Helderberg mountains : Albany and Schoharie counties.

Platyceras retrorsum, var. abnormis.

PLATE LX. FIG. 4 *a*, *b*, *c*.

This shell resembles the *P. retrorsum*, except that it is more depressed on the upper side, and the aperture transverse. The lower side of the last volution is flattened and produced, the peristome on that side extending in a broad linguiform process much beyond the upper or anterior side, leaving a deep sinus upon the back of the shell. This peculiarity can scarcely be regarded as of specific importance. The upper side is plicate, and transversely marked by lamellose striæ.

Fig. 4 *a*. Upper side of the shell, showing the plications and the strong lamellose striæ.
Fig. 4 *b*. The lower side of the same, which is marked only by concentric lamellose striæ.
Fig. 4 *c*. An enlargement of the striæ on the upper side.

Geological position and locality. In the middle part of the Lower Helderberg group : Schoharie county.

Platyceras intermedium (n. s.).

PLATE LVIII. FIG. 11.

SHELL arcuate subspiral, making a little more than two volutions, the last one free and becoming gradually straight. The apex is very minute, consisting of little more than a single volution with the parts closely contiguous.

SURFACE marked by fine lamellose transverse striæ, which are slightly undulated upon the body of the shell.

The specimen presents a few slight undulations upon the surface, but is not ridged or plicate like the two preceding ones.

Fig. 11. View of the upper side of the spire, which is incorrectly represented at the apex. The apparent contraction toward the anterior side of the aperture is due to accident.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Schoharie county.

Figures 12 *a*, *b*, are casts of a species having free volutions, probably of the preceding or of *P. retrorsum*, from the shaly limestone near Catskill.

Platyceras unguiforme (n. s.).

PLATE LIX. FIG. 1, 2, 3 & 4.

SHELL oblique, arcuate, subspiral : volutions one or two, more or less contiguous at the apex; last volution angular, extending in a nearly straight or slightly curved direction towards the aperture : aperture oblique subovoid; peristome sinuous.

SURFACE longitudinally plicate, and marked by fine crowded undulating lamellose striæ.

The specimens which I have referred to this species present some variety of form and surface marking; and it is not improbable that the examination of a larger number of specimens may prove that there are two distinct species, one having more numerous plications than the other.

Fig. 1 *a*, *b*, & 2. Views of young individuals of this species.

Fig. 3 *a*. Profile view from the dorsal side, showing the spire and the broad flat plications.

Fig. 3 *b*. View of the upper side of another specimen, with more numerous plications.

Fig. 4 *a*, var. *multicarinatum*. View of the lower side of a specimen which has numerous narrow plications.

Fig. 4 *b*, *c*. Views of the upper sides of similar specimens.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Albany and Schoharie counties.

Platyceras dilatatum (n. s.).

PLATE LIX. FIG. 5 *a* – *i*, & 6 *c*.

SHELL obliquely depressed-conical, with a single minute contiguous volution at the apex, below which the shell expands very rapidly, particularly on the lower side, while a subangular ridge may be traced from the apex nearly to the base : aperture subcircular or transversely broad-oval; peristome undulated by the more or less numerous plications of the surface.

SURFACE, in the young shell, marked by obscure transverse striæ and more conspicuous longitudinal striæ; while in the older shell the right side

becomes finely and obscurely plicate towards the aperture, and the left side marked with two or three coarse plications, while the transverse striæ become more conspicuous and the longitudinal striæ more subdued or obsolete.

This species bears some resemblance to *P. ventricosum*; but the last volution expands laterally much more rapidly, and is never so ventricose as in that species; while at the same time the obtusely angular form of the young shell, and the plicate margins of the older ones, sufficiently distinguish this species.

Fig. 5 *a*, *b*. Young specimens of this species.

Fig. 5 *c*. A larger specimen, showing a shallow sinus on the back and the commencement of small plications on the right side.

Fig. 5 *d*. A larger specimen where the plications are more fully developed.

Fig. 5 *e*. Dorsal view of a similar specimen in which the plications are more developed, and the obtuse carina extending from the apex is more defined, and ending in a broad extension in front (which is broken off in the specimen figured).

Fig. 5 *f*. View of the aperture of the same specimen, showing the incipient plications upon the left side of the aperture. This feature is much more strongly developed in some specimens than in this one.

Fig. 5 *g*. A specimen in which the spiral carina is more strongly developed, and is marked by a deep sinuosity in the peristome.

Fig. 5 *h*. An enlargement of the surface, showing the bending of the striæ as they cross the carina.

Fig. 5 *i*. An enlargement of the surface of a young specimen, where the longitudinal striæ are more conspicuous.

Fig. 6 *c*. This specimen is probably one of the same species, which is less expanded towards the aperture, and has one more volution at the apex than the preceding figures.

Geological position and locality. In the middle portion of the shaly limestone: Base of Helderberg mountains, Albany county.

Platyceras gibbosum (n. s.).

PLATE LIX. FIG. 6 *d* – *g*, & 7 *a*.

SHELL obliquely subovoid, with one or two closely contiguous volutions at the apex, from which the last one expands more or less rapidly, becoming ventricose in the middle and below; upper part of the last volution rounded, becoming angular and plicate below: aperture somewhat rounded; peristome sinuous.

SURFACE marked by fine undulating transverse striæ, which are crossed by much finer obscure or obsolete longitudinal striæ.

This species differs from the preceding, in spreading less rapidly from the apex, and in being more gibbous on the back of the last volution, while it does not show the fine plications on the right side of the shell near the aperture.

The specimen figure 6 *a b* has been referred with doubt to this species, but is probably distinct; and fig. 6 *c*, though having some of the features of this species, has been vertically compressed, which renders it more rotund : it probably belongs to the preceding.

Fig 6 *d*. View of the aperture of a large specimen of this species.

Fig. 6 *e*. A similar specimen, with less strongly plicated margins and a smaller spire.

Fig. 6 *f*. The upper side of the spire of fig. 6 *e*. The specimen is not quite symmetrical in its convexity.

Fig. 6 *g*. The upper side of the spire of the specimen fig. 6 *d*.

Fig. 7 *a*. The lower side of a smaller specimen, showing strong plications.

Geological position and locality. In the central portion of the Lower Helderberg group : Albany county.

Platyceras sulcoplicatum (n. s.).

PLATE LIX. FIG. 7 *b*.

SHELL irregularly subhemispheric : apex posterior, minute, consisting of a single plain volution; body volution abruptly expanding, ventricose: aperture somewhat quadrangular; peristome sinuate.

SURFACE very strongly plicate; plications four or five, sulcate, with one or two shallow grooves.

This species is very peculiar in its broadly expanded last volution, which is more strongly plicated than any other species of the same size in this group of strata. The figure does not well represent the specimen.

Fig. 7 *b*. The figure represents the specimen lying with the aperture downward.

Geological position and locality. In the central part of the shaly limestone of the Lower Helderberg group : Schoharie county.

Platyceras platystomum (n. s.).

PLATE LX. FIG. 1 *a b*, & 2; and PLATE LXI. FIG. 1 *a*, *b*, *c*.

SHELL obliquely depressed-conical, arcuate on the upper part of the first volution; the apex obtuse, consisting of about a single close volution: aperture expanded, campanulate, and sometimes slightly reflexed.

SURFACE marked by longitudinal plications, which are more or less strongly developed, and are crossed by fine closely arranged lamellose striæ, which are often crowded into wrinkles upon the middle and lower part of the shell.

This species bears some resemblance to *P. perplicatum* (Plate LIX, fig. 8), but is more obtuse at the apex and more ventricose below.

PLATE LX.

Fig. 1 *a*. View of the right side of a specimen, the apex of which is broken off.

Fig. 1 *b*. The cast of a similar specimen, preserving the impressions of the plications.

Fig. 2. A similar specimen, showing a little irregularity at the apex. The plications are shown only on one side.

PLATE LXI.

Fig. 1 *a*. The left posterior side of a specimen, which is crushed on the upper side.

Fig. 1 *b*. The anterior side of the same, the distortion being due to pressure.

Fig. 1 *c*. A young individual which is somewhat distorted by pressure.

Geological position and locality. In the central part of the Lower Helderberg group: Albany and Schoharie counties.

Platyceras platystomum, var. alveatum.

PLATE LX. FIG. 3 *a*, *b*, *c*.

SHELL somewhat hemispheric: apex posterior, abruptly incurved, consisting of a single volution; body volution abruptly spreading, very ventricose: aperture circular; peristome sinuate on the posterior side, and entire on the anterior side.

SURFACE plicate on the posterior and left sides, the right side showing some longitudinal pustules; the whole marked by fine closely arranged transverse striæ, which are somewhat wrinkled on certain parts of the shell.

Fig. 3 *a*. The right side, showing the upper side of the spire.

Fig. 3 *b*. The left posterior side. Fig. 3 *c*. View of the aperture.

Geological position and locality. In the middle part of the Lower Helderberg group: Schoharie county.

Platyceras bisulcatum (n. s.).

PLATE LX. FIG. 6 *d*, *e*.

SHELL obliquely and very depressed-subconical : apex consisting of one or two small volutions, which are free from plications and slightly oblique; last volution free, abruptly expanding and becoming ventricose towards the aperture : aperture round; peristome sinuate, somewhat reflexed.

SURFACE, on the upper or right side of the body-volution, marked by two strong longitudinal furrows, which divide that side of the shell into three broad lobes or plications, the opposite side being obscurely plicate; transversely marked by lamellose striæ, which are abruptly undulated on the depressions and elevations of the surface, and obscurely marked by fine longitudinal striæ.

The first volution is broken off in the specimen figured, and the aperture a little distorted by pressure.

Fig. 6 *d*. View of the upper side of the spire, showing the two sharp grooves and the broad lobes.

Fig. 6 *e*. The left side, showing the sinuous striæ with an undefined longitudinal plication : there are, besides this, one or two obscure plications.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Schoharie county.

Platyceras pileiforme (n. s.).

PLATE LXI. FIG. 3 *a*, *b*.

SHELL very depressed-conical or hemispheric : apex subcentral, consisting of a single minute volution, from which the surface slopes almost equally on all sides to the margin : aperture nearly round ; peristome sinuous.

SURFACE longitudinally plicated; plications broader below, and scarcely reaching to the apex : a few pustulose markings on the sides and near the apex; concentrically striated by fine closely arranged striæ.

This species is readily distinguished by its depressed form and nearly central apex, consisting, when entire, of a single minute volution. The pustulose markings seem to be characteristic of the species.

Fig. 3 *a*. The upper side of a specimen in which the apex is partially broken off. [The minute volution is seen on the specimen, though not represented in the figure.]

Fig. 3 *b*. Profile view of a young specimen.

Geological position and locality. In the central part of the Lower Helderberg group : Schoharie county.

Platyceras perlatum (n. s.).

PLATE LXI. FIG. 4 *a*, *b*.

SHELL extremely depressed-subhemispherical, with the apex subcentral and obtusely pointed, very gradually sloping to the margin : aperture nearly circular, somewhat broader posteriorly; peristome scarcely sinuate.

SURFACE marked by fine undulating striæ.

This species is more depressed than the preceding; and from the appearance of the surface, which preserves but a small portion of the shell, it has never been marked by plications. The cast on the anterior side is contracted in a broad concentric groove, but it presents no marks of muscular impressions.

Fig. 4 *a*. View looking upon the summit of the fossil. The indentation near the summit may have been due to the involution of the apex of the shell, which afterwards became solid, as the apex of the cast is not broken.

Fig. 4 *b*. An oblique postero-lateral view of the specimen.

Geological position and locality. In the central part of the Lower Helderberg group : Schoharie county.

Platyceras calantica (n. s.).

PLATE LXII. FIG. 1, 2, 3, 4, 5.

SHELL obliquely or arcuately subconical : apex consisting of one and a half to two minute volutions, from which the body of the shell expands very abruptly, becoming extremely ventricose below and broadly campanulate at the aperture; peristome scarcely sinuous.

SURFACE marked by fine transverse striæ and a few broad shallow wrinkles.

This species has some resemblance to the *P. ventricosum*; but the apex is more minute, and in that shell the volutions expand regularly and rapidly, while in this one the expansion is more abrupt and the shell more extremely ventricose. This species shows some transverse wrinkles, which are often preserved in the cast; but this feature has not been observed in *P. ventricosum*.

Fig. 1. View of the upper side of the spire of a specimen where the apex is entire. The shell is nearly all exfoliated from the body of the specimen.

Fig. 2. A similar but less symmetrical specimen, preserving little of the shell.

Fig. 3. Anterior view of fig. 1.

Fig. 4. View of the upper side of the spire of a smaller specimen, in which the apex is broken off.

Fig. 5. A smaller specimen of, apparently, the same species, having the apex broken off and the shell compressed from above.

Geological position and locality. In the upper part of the shaly limestone : Schoharie and Albany counties; Becraft's mountain.

Platyceras obesum (n. s.).

PLATE LXII. FIG. 6 & 7.

SHELL large, elevated hemispheric : apex minute, lateral, from which the shell expands abruptly, becoming extremely ventricose in the middle and slightly contracted towards the margin, and again spreading: aperture campanulate; peristome sinuate.

SURFACE above marked only by fine transverse striæ, and towards the aperture by short strong flattened plications, upon which the transverse striæ are strongly lamellose.

This species differs from the *P. perlatum* in the proportionally much greater elevation, the lateral position of the apex of the spire, and the plicate margin of the aperture.

Fig. 6. Lateral view of the specimen, from which the shell is nearly all exfoliated.

Fig. 7. A portion of the peristome, from which the upper part of the shell has been worn away, showing the plications.

Geological position and locality. In the upper part of the shaly limestone at Becraft's mountain, and in the upper pentamerus limestone near Schoharie.

The name ORTHONYCHIA (proposed in the Report of the Fourth Geological District in 1843), for certain forms of this group of fossils, would apply to some of the species among those of the Lower Helderberg rocks, in which the body of the shell is straight or curving, gradually diminishing above, arched or in some degree spiral at the apex, with the last volution or more quite free.

The gradations, however, are so imperceptible, that it is scarcely possible to separate any collection of species that do not embrace other than these forms alone; since on the one side they pass to those having the spire closely enrolled with one or more volutions, and, on the other, to those with a simply arcuate apex, and thence to the species which are essentially straight. For the straight forms with cancellated surfaces, and often with the addition of longitudinal plications, I had proposed the name IGOCERAS; and should there prove to be a sufficient reason for the separation, this name may be adopted.

The species with a single small volution at the apex, and the volutions below elongate, straight or subspiral, are arranged principally on Plate LXIII.

Platyceras lamellosum (n. s.).

PLATE LXIII. FIG. 1, 2, 3.

SHELL consisting of a single small volution at the apex, which is nearly in the same plane, and from which the shell gradually enlarges and extends, at first in a gradually oblique direction, and then bends suddenly downwards, making about another volution: aperture expanded, transversely broad-oval.

SURFACE with strong transverse imbricating lamellose ridges, the spaces between which are marked by fine longitudinal striæ.

This species differs conspicuously from any other at present known to me in these strata, in its sharp lamelliform ridges, as well as in the general form of the shell.

Fig. 1 *a*, *b*. The anterior and posterior sides of a small specimen.

Fig. 1 *c*. Enlargement of the surface, showing the undulating transverse lamellæ and the fine longitudinal striæ.

Fig. 2 *a*, *b*. Views of the anterior and posterior sides of a larger individual.

Fig. 3. A larger individual, in which the transverse lamellæ are much subdued : the longitudinal ridge is an accidental feature.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains, Albany county.

Platyceras spirale (n.s.).

PLATE LXIII. FIG. 4, 5, 6, 7, 8, 9.

SHELL spirally ascending : apex consisting of a single minute close volution, below which are one or two widely separated and gradually enlarging volutions : aperture spreading, rounded or broad oval; peristome sinuate.

APEX and upper part of the shell smooth, or with only fine transverse striæ, more or less distinctly plicated on one side below, with strong lamellose undulating striæ.

This species presents considerable variation during its different stages of growth, and in the degree of development of the plications; but there seems to be no real specific distinction among the specimens examined.

Fig. 4. A young individual of this species, in which no plications are developed.

Fig. 5 *a*. A larger specimen, in which the plications are very strongly developed on the right posterior side of the shell.

Fig. 5 *b*. The posterior side of the same shell.

Fig. 6. A specimen of equal size with the preceding, in which the plications are but partially developed, or shown principally in the undulations of the striæ of the surface.

Fig. 7. A similar specimen which is smooth on the anterior side, and showing only two or three plications on the posterior side.

Fig. 8. A more elongated specimen, with strongly developed plications. (The upper part has been broken off, and presents some imperfection at the junction of the two parts.)

Fig. 9 *a*. The anterior side of another specimen, in which plications are but faintly developed.

Fig. 9 *b*. The posterior side of the same. The expansion towards the aperture is increased beyond the natural width, by compression.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Albany and Schoharie counties.

Platyceras incile (n. s.).

PLATE LXIII. FIG. 10, 12 & 13.

SHELL spirally ascending, with one or more minute close volutions at the apex, below which are one or two widely separated volutions : volutions below the apex rounded, gradually increasing in size to the aperture, which is round, scarcely expanded, with the peristome somewhat undulated.

SURFACE marked by fine transverse striæ, and a single depressed plication following the direction of the suture line to the aperture, near which are other obscure plications.

This differs from the preceding species in its smoother aspect, and in having but a single depressed plication marking the extension of the volutions above the aperture.

Fig. 10. The lower part of the shell, consisting of a single volution.

Fig. 12. A specimen preserving imperfectly the apex and nearly two volutions below. The specimen is somewhat flattened from pressure.

Fig. 13. A fragment which is probably the apex of a specimen of this species.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Schoharie county, and Virginia.

Platyceras tubæforme (n. s.).

PLATE LXIII. FIG. 11.

SHELL with the spire rapidly ascending; apex unknown : lower volutions free, rounded, gradually expanding above and rapidly expanding towards the aperture, which is broadly campanulate; peristome reflexed.

SURFACE marked by fine transverse striæ, which are strongly lamellose towards the aperture.

The upper part of the shell is broken off, and only a single volution from the aperture remains. The freedom from plications, the broader curvature of the volutions, and the broadly expanded aperture, serve to distinguish this species from the preceding, to which it bears some general resemblance.

Fig. 11. A fragment preserving a little more than one volution.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Becraft's mountain, Columbia county.

Platyceras newberryi (n. s.).

PLATE LXIII. FIG. 14 *a* – *e*.

SHELL subdiscoidal, with the last volution expanded : volutions about three, nearly in the same plane; the first two minute and closely involved, the last one free, somewhat rapidly expanding, flattened upon the back and becoming ventricose towards the aperture : aperture rounded or broad-oval.

SURFACE marked by strong transverse or slightly oblique nodes or ridges upon the dorso-lateral angles of the last volution, about eleven or twelve on each side, which are sometimes connected by a low ridge across the back (the two upper volutions being rounded and free from such ridges). Entire surface marked by regular even threadlike longitudinal striæ.

This species is very remarkable in its form and surface markings; the volutions being more nearly in the same plane than any other form among all those before me, while the transverse nodes form a very striking feature. The longitudinal striæ are very strongly developed, and the transverse striæ are not visible on the upper part of the shell.

In the specimen figured, the shell is preserved near the apex, while the remaining portion is only a cast. Another specimen, which is an older shell, is more rapidly expanded below, and the transverse nodes become obsolescent towards the aperture.

Fig. 14 *a*. Dorsal side of the last volution.
Fig. 14 *b*. View of the top of the spire.
Fig. 14 *c*. The lower side of the shell.
Fig. 14 *d*. Posterior view, showing, partially, the aperture.
Fig. 14 *e*. Enlargement of the surface, showing the longitudinal striæ.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Becraft's mountain, Columbia county.

The three following species are straight, or slightly arcuate at the apex, but without volutions.

Platyceras plicatum.

PLATE LXIV. FIG. 1 – 5.

Calceola plicata : CONRAD, Annual Report on the Palæontology of New-York, 1840, p. 207.

SHELL obliquely conical, not incurved : apex acute sublateral, expanding and becoming ventricose below : aperture rounded, oblique; peristome regularly sinuate on the right side, shorter and plain or broadly sinuate on the left side.

SURFACE cancellated by transverse lamellose striæ, and by longitudinal rounded or threadlike striæ : one side regularly marked by broad rounded plications which originate at one-third or one-half the distance from beak to base.

This species varies but little in its general form, being sometimes a little more slender. The plications are more strongly developed in some of the specimens than in others, and the plicated side is always more extended; the shorter side of the aperture sometimes showing one or two broad undulations.

Mr. CONRAD described the *Calceola plicata* as follows : "Shell longitudinally "striated; plicated towards the aperture, the margin of which is waved." The original specimen labelled by Mr. CONRAD leaves no doubt of the species to which this name was applied.

Fig. 1. A young specimen in which no plications are developed.
Fig. 2. A more slender specimen in which the plications are strongly marked.
Fig. 3 & 4. A larger individual, in which the plications are but moderately developed.
Fig. 5. A large specimen which is compressed, the view showing a width greater than the natural width of the shell.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Albany and Schoharie counties.

Platyceras elongatum (n. s.).

PLATE LXIV. FIG. 6 & 10.

SHELL elongate-conical, straight or slightly bent near the apex, which is central or subcentral : aperture somewhat rounded.

SURFACE cancellated by undulating transverse lamellose striæ and longitudinal rounded striæ, which, in the partially worn surfaces, are of nearly equal strength. One or two longitudinal undulations mark the surface, but there are no distinct plications.

This species is much more elongated and more nearly straight than the preceding one, and the surface is free from distinct plications.

Fig. 6. A young specimen of this species.

Fig. 10. A large individual from which the extremity of the apex is broken, and the shell partially exfoliated from the lower part.

Geological position and locality. In the shaly limestone : Schoharie county.

Platyceras elongatum? var.

PLATE LXV. FIG. 5 *a*, *b*.

SHELL slightly arcuate, tapering very gradually above, with a few obscure undulations towards the base.

SURFACE cancellated by transverse and longitudinal striæ.

The specimen figured, with another of similar character, present some deviations from the specimen fig. 10, Plate LXIV, and appear never to have been so extremely elongated, and are also a little curved, while that one is rigidly straight except near the apex.

Fig. 5 *a*. A fragment of a specimen, natural size.

Fig. 5 *b*. An enlargement of the surface striæ.

Geological position and locality. In the upper part of the shaly limestone of the Lower Helderberg group : Schoharie county.

Platyceras pyramidatum (n. s.).

PLATE LXIV. FIG. 7, 8 & 9.

SHELL pyramidal, somewhat obtusely quadrangular and ventricose below, prolonged above into a central slightly inclined elongato-conical apex: aperture subquadrangular.

SURFACE marked by a few strong plications near the aperture on one or two sides; transversely marked by lamellose striæ, and longitudinally? by rounded equal striæ.

This species is distinguished by its obtusely quadrangular pyramidal form below, while its extension above is rounded and elongato-conical.

The shell is mostly exfoliated from the surface in the specimens figured; some remains of the transverse striæ being visible, though the longitudinal striæ cannot be seen.

Fig. 7 & 8. Two views of the same specimen. Fig. 9. View of a smaller specimen.

Geological position and locality. In the upper part of the shaly limestone: Schoharie county.

Platyceras arcuatum (n. s.).

PLATE LXV. FIG. 6.

SHELL elongate arcuato-conical, making about one-third of a volution which is essentially in the same plane, gradually spreading below: aperture nearly round.

SURFACE marked by fine transverse striæ, which are undulated in passing over some undefined longitudinal elevations and depressions of the surface; without distinct plications or visible longitudinal striæ.

Geological position and locality. In the upper part of the shaly limestone: Schoharie county.

Platyceras undulostriatum (n. s.).

PLATE LXV. FIG. 1 *a*, *b*.

SHELL small, consisting of about two volutions, the first minute and rounded; the last one becoming free, spreading and subquadrangular

below, marked on the lower side by a sharply defined spiral groove, and on the upper side by a broader depression having a narrow rounded dorsal lobe and a subangular ridge above; while below, or within the narrow groove on the lower side, is a less strongly defined parallel ridge : aperture subquadrangular; peristome sinuate.

SURFACE marked by transverse undulating ridges, and by fine longitudinal abruptly undulating striæ, which, under a lens, appear to be crenulate.

This small specimen appears to be a mature shell, and possesses characteristics not observed in any other species. It bears a remote resemblance to *P. trilobatum*; but the volutions are fewer, that one having more than two contiguous volutions, and, when of the size of the specimen here figured, having a very different form.

Fig. 1 *a*. View of the upper side of the spire.
Fig. 1 *b*. The lower side, showing the narrow groove in the last volution.

Geological position and locality. In the upper part of the shaly limestone of the Lower Helderberg group : Becraft's mountain, Columbia county.

The following species are from the Upper Pentamerus limestone, and have not been observed in the Shaly limestone below.

Platyceras clavatum (n. s.).

PLATE LXV. FIG. 2.

SHELL spiral; the apex consisting of about two symmetrical contiguous volutions, which are gradually expanding : below the second volution the shell is expanded somewhat abruptly, swelling out in an ovoid form : aperture elongate-ovate; peristome sinuous.

SURFACE marked by fine undulating lamellose transverse striæ, which, in well-preserved specimens, are crossed by longitudinal undulating striæ.

This species, in the extreme length of the aperture and form of the body-volution, differs from any other in this formation.

Fig. 2. A specimen of this species, from which the shell is nearly exfoliated.

Geological position and locality. In the upper pentamerus limestone : Schoharie county.

Platyceras curvirostrum (n. s.).

PLATE LXV. FIG. 3 *a*, *b*.

SHELL with the spire gradually ascending : body-volution somewhat spirally trilobate, from two shallow depressions along the back of the shell, one on the upper and one on the lower side of the volution; the last volution free, and gradually expanding towards the aperture, which is subquadrate : apex unknown.

SURFACE marked by lamellose striæ, which are strongly undulated in passing over the longitudinal depressions in the body-volution, and are more strongly marked towards the aperture. Obscure remains of longitudinal striæ are preserved on some parts of the shell.

Fig. 3 *a*. The upper side of the spire, from which the surface is nearly all exfoliated.
Fig. 3 *b*. The posterior side, showing the form of the aperture.

Geological position and locality. In the upper pentamerus limestone : Schoharie county.

Platyceras agreste (n. s.).

PLATE LXV. FIG. 4, 7.

SHELL with the body-volution somewhat arcuately ovoid : apex minute; the last volution spreading somewhat rapidly, rounded on the upper side and a little contracted below : aperture large, broadly oval; peristome with a broad deep sinus on the anterior side.

SURFACE marked by close transverse lamellose striæ, which are crossed by finer longitudinal striæ.

Fig. 7. The lower side of the specimen, showing the aperture.
Fig. 4 is a specimen having a similar form of the body-volution, but with the apex more acute. The shell on the upper part of the volution is marked by abruptly undulating longitudinal striæ, and, near the base, the surface becomes roughly cancellated by the two sets of striæ.

Geological position and locality. In the upper pentamerus limestone : Carlisle, Schoharie county.

Pleurotomaria labrosa (n. s.).

PLATE LXVI. FIG. 1 – 5; and PLATE LVII. FIG. 6 *a*, *b*.

SHELL rhomboid-ovate. Spire little elevated above the body of the shell; volutions three or four; the upper ones small and moderately increasing, the last one ventricose, much expanded on the outer side, and subangular : aperture broadly ovate; the columellar lip extremely thickened, the callosity extending to the outer lip.

SURFACE marked by prominent spiral ridges with wider furrows between, and, on the upper part of the volution, by a broader band or groove, which is margined by carinæ : lines of growth marked by strong elevated lamellose striæ, which are undulated in passing over the spiral ridges; those marking the broader spiral band are less strongly elevated, and make a single retral curve, indicating the marginal sinus.

The entire surface has a reticulated aspect; the spiral ridges being equidistant, while the lamelliform striæ of growth are often irregular. In different degrees of exfoliation, the surface presents some variety of aspect, some of the lines remaining on the cast. The specimens figured are all distorted to a greater or less degree.

This species resembles very closely the *P. balteata* of PHILLIPS, a species from the Wenlock limestone.

Fig. 1 *a*. An imperfect specimen from the Shaly limestone.

Fig. 1 *b*. An enlargement of the surface of the same.

Fig. 2 *a*. A cast of the same species : view of the aperture, which is filled with stone.

Fig. 2 *b*. View of the exterior of the specimen.

Fig. 3 *a*. The exterior of a specimen where the shell is mostly removed, showing the spiral band and the sinuosity in the peristome.

Fig. 3 *b*. View of the aperture of the same, showing the thickened columellar lip.

Fig. 3 *c*. An enlargement of the surface markings.

Fig. 4 *a*, *b*. Two views of another individual, showing in one of the figures the thickened lip, which, on the upper side, extends as far as the marginal sinus.

Fig. 5 *a*, *b*. Two views of a crushed specimen, showing in one of the figures the externally thickened columellar lip.

The same species is illustrated in fig. 6 *a b*, Plate LVII.

Geological position and locality. In the upper pentamerus limestone : Carlisle and Schoharie, Schoharie county; and a single specimen in the shaly limestone at the base of the Helderberg mountains, Albany county.

Euomphalus disjunctus (n. s.).

PLATE LXV. FIG. 8; and PLATE LXVII. FIG. 4 *a*, *b*.

SHELL discoid: volutions about one and a half, flat or depressed-convex on the lower side, with a wide umbilicus; upper side of volutions rounded: aperture suboval, the lower side being a little flattened. Surface unknown.

This species is readily distinguished by the paucity of its volutions, which are not contiguous.

PLATE LXV.

Fig. 8. The lower side of a weathered specimen.

PLATE LXVII.

Fig. 4 *a*. The lower side of a cast of this species.

Fig. 4 *b*. Profile view of the same.

Geological position and locality. In the upper pentamerus limestone: Carlisle and Schoharie, Schoharie county.

Euomphalus sinuatus (n. s.).

PLATE LXIX. FIG. 1 *a*, *b*.

SHELL discoid, with about three volutions. Spire slightly elevated above the outer volution: volutions contiguous, rounded, a little more convex above than below: aperture oval; peristome sinuate on the lower side.

SURFACE marked by numerous fine transverse striæ, which pass over the upper side of the volution in nearly a direct line, bending backwards on the periphery, and continuing in that direction to the middle of the lower side of the volution, where they again bend forward, leaving a sinuosity, which, in one specimen, is distinctly marked upon the surface for half a volution.

This species is readily distinguished from the preceding by its more numerous and contiguous volutions, which are less flattened on the lower side.

Fig. 1 *a*. The lower side of an imperfect specimen, where the umbilicus is filled with stony matter.

Fig. 1 *b*. The upper side of a larger specimen, the apex of which is imperfect.

Geological position and locality. In the tentaculite limestone : Herkimer county.

Bucania profunda (n. s).

PLATE LXVIII. FIG. 1 – 3.

SHELL convolute : volutions exposed, about four, flattened; inner ones with the width more than twice the depth, becoming more ventricose towards the aperture; sides obtusely angular, the casts obscurely carinated upon the back : aperture very abruptly and widely expanded.

This species is common in the Upper Pentamerus limestone; occurring in the condition of the specimen fig. 2, more rarely as fig. 3, and a single specimen has been obtained where the impression of the widely expanded aperture is preserved upon the surface of the stone. The true extent of this part of the shell cannot be ascertained, since the margin is not defined.

This species may be compared with *Bellerophon dilatatus* (SOWERBY), MURCHISON, Silurian System, Part ii, pa. 627, pl. 12, f. 23 & 24 (Siluria, pl. 25, f. 5 & 6); PORTLOCK, Geological Report of Londonderry, etc., pa. 398, pl. 29, f. 1 : also with *Bellerophon macrostomum*, RŒMER, Rheinische Uebergansgebirge, pa. 80, pl. 2, f. 6 *a*, *b*; but our species differs from either of these.

Fig. 1 *a*. Dorsal view of a cast, in which the expanded peristome is shown upon the surface of the stone.

Fig. 1 *b*. Lateral view of the same. The representation of the volutions is incorrect.

Fig. 2 *a*. A small specimen in which the expanded portion is broken off.

Fig. 2 *b*. Lateral view of the same.

Fig. 3 *a*. A specimen having a part of the outer volution broken off.

Fig. 3 *b*. The umbilicus, showing three volutions.

Fig. 3 *c*. Dorsal view of the same, showing an obscure carination.

Geological position and locality. In the upper pentamerus limestone : Schoharie and Carlisle, Schoharie county.

CEPHALOPODA.

THE fossils of this class are comparatively rare in the Lower Helderberg group, and the condition of the specimens is generally such as to render the determination of species quite unsatisfactory. A single species of ONCOCERAS, one of CYRTOCERAS, and a few species of ORTHOCERAS, constitute all that we know at the present time.

While in this period the Gasteropoda acquire a development unknown in any other geological period of our country, the development of the Cephalopoda appears almost at the minimum degree, presenting less variety of form than in the preceding and following geological periods. It is not improbable, however, that some localities may yet furnish a greater number of species and a greater variety of forms.

Oncoceras ovoides (n. s.).

PLATE LXIX. FIG. 2 *a*, *b*.

SHELL ovoid, slightly arcuate below the apex, expanding, ventricose; outer cavity large. Septa gently concave; those near the apex distant from each other less than one-eighth of an inch, the distance increasing in the outer divisions : several of the later septa, adjacent to the outer cavity, crowded closely together. Surface unknown.

The only specimen which I have seen is a cast; the apex is removed, and otherwise imperfect.

Fig. 2 *a*. A longitudinal section of the specimen, showing the crowded septa near the outer chamber.

Fig. 2 *b*. The exterior of the cast of the same specimen.

Geological position and locality. In the upper part of the tentaculite limestone : Herkimer county.

Cyrtoceras subrectum (n. s.).

PLATE LXIX. FIG. 3 *a*, *b*, *c*, *d*.

SHELL terete, gradually tapering, very gently curving; section scarcely

circular, the shortest diameter being between the ventral and dorsal sides. Septa numerous, approximate, very gently concave; outer chamber deep. Siphuncle dorsal, somewhat moniliform or constricted at its passage through the septa; internally marked by sharp elevated longitudinal striæ, the impressions of which are preserved in casts of the interior. Surface unknown.

I have seen only casts of imperfect specimens of this species, and in none of these is the apex preserved. Although but slightly curved, the specimens are uniformly so; and one or two fragments, from near the apex, show a greater curvature in that part than below.

Fig. 3 *a*. A cast preserving a part of the outer chamber and about twenty septa. The back is somewhat worn, so that the form of the siphuncle is seen.

Fig. 3 *b*. Lateral view of a fragment of a larger individual, showing the cast of the interior of the siphuncle.

Fig. 3 *c*. A smaller individual, lateral view. The apparent rapid attenuation above is due to compression of the lower part of the specimen.

Fig. 3 *d*. A portion of the cast of the siphuncle, with the filling between the adjacent septa. The matter filling the siphuncle does not apparently differ from that filling other parts of the fossil; but it has been deposited between thin elevated lamellæ originally forming part of the walls of the siphuncle, and which, with all the shelly matter of the specimen, has been removed.

Geological position and locality. In the upper part of the tentaculite limestone: Herkimer county.

Orthoceras longicameratum (n. s.).

PLATE LXX. FIG. 1; and PLATE LXXI. FIG. 1 & 5.

SHELL elongated, very gradually tapering; chamber extremely elongated. Septa numerous, highly arched, about four or five in the space of the diameter of the shell. Siphuncle moniliform. Surface unknown.

The specimens of this, and of all the other species in the rocks of this age, are so obscure as to afford barely the means of specific distinction. The species under consideration is remarkable for the long outer chamber and the highly arched septa.

PLATE LXX.

Fig. 1. The siphuncle has been filled with crystalline matter, and the swollen portions are concave above and beneath, indicating a thickening of the septum at its junction with the narrower parts of the siphuncle. Some remains of the septa are still perceptible.

PLATE LXXI.

Fig. 1. A fragment of a large specimen preserving a part of the outer chamber, with about fourteen of the first chambers above.

Fig. 5. A specimen showing a longitudinal section, apparently of the same species, the septa being proportionally a little more distant.

Geological position and locality. In the pentamerus limestone of the Lower Helderberg group : Albany and Schoharie counties.

Orthoceras rigidum (n. s.).

PLATE LXX. FIG. 3 *a* – *d*.

SHELL elongate, gradually tapering; section circular. Septa moderately convex, distant from each other about one-sixth the diameter of the tube. Siphuncle central, narrow in its passage through the septum.

SURFACE marked by fine sharply-elevated equal transverse striæ.

This fine species is only known in the fragment figured, which preserves more than forty of the septa. The surface striæ are more finely and sharply marked than in any other species that has come under my observation.

Fig. 3 *a*. A fragment of this species, having the shell almost entirely removed.

Fig. 3 *b*. A continuation of the same specimen.

Fig. 3 *c*. Transverse section, as shown in the line of fracture of fig. 3 *b*.

Fig. 3 *d*. Enlargement of the striæ. The position of the figure represents the striæ in the reverse of their natural relation, which is horizontal.

Geological position and locality. In the pentamerus limestone of the Lower Helderberg group : Herkimer county.

Orthoceras subtextile (n. s.).

PLATE LXXI. FIG. 2.

SHELL gradually tapering : siphuncle subcentral : septa unknown.

SURFACE marked by strong transverse striæ or low ridges, and by a much finer set of striæ in the same direction, and the latter cancellated by a still finer set of longitudinal striæ.

A single fragment only of this species has been observed, but the peculiarity of the surface marking seems sufficient to distinguish it from any other species.

Fig. 2. The specimen, natural size.

Geological position and locality. In the lower part of the pentamerus limestone of the Lower Helderberg group : Schoharie.

Orthoceras clavatum (n. s.).

PLATE LXXI. FIG. 4.

The specimen is a fragment, preserving a part of the outer chamber and several of the septa above. The form is somewhat abruptly tapering, and differs from any other species in the same group of strata.

Geological position and locality. In the lower part of the pentamerus limestone : Schoharie.

Orthoceras —— ?

PLATE LXXI. FIG. 3.

The specimen is marked by thin slightly convex septa; but having no others of similar character, it can scarcely be characterized.

The condition of the Orthocerata in this group of strata is usually very unsatisfactory, all the species occurring in a fragmentary condition.

Geological position and locality. In the pentamerus limestone : Schoharie.

Orthoceras tenuiannulatum (n. s.).

PLATE LXXII. FIG. 1.

SHELL cylindrical, very gradually tapering : septa unknown.

SURFACE marked by thin abruptly elevated annulations, and by longitudinal striæ, with obscure indications of fine transverse striæ.

Fig. 1. A fragment, natural size.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Albany county.

Orthoceras helderbergiæ (n. s.).

PLATE LXXII. FIG. 2.

SHELL very gradually tapering; section circular. Septa distant about one-fourth the diameter of the shell; convexity of the septa nearly equal the space between them. Siphuncle small, central. Surface unknown.

The specimen figured is compressed, and the lines of septa obscure. In another specimen, preserving a part of the outer chamber and fifteen of the succeeding chambers, the characteristic features are well preserved.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Carlisle and Schoharie, Schoharie county.

Orthoceras perstriatum (n. s.).

PLATE LXXII. FIG. 3.

SHELL rapidly tapering; outer chamber large : septa distant from one-fourth to one-third the diameter of the shell.

SURFACE strongly striated longitudinally : transverse striæ?

This species is marked by its rapid attenuation and strong longitudinal striæ.

Fig. 3. A fragment preserving part of the outer chamber and several of the chambers above, from which the shell is partially exfoliated.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Schoharie, Schoharie county.

Orthoceras rudis (n. s.).

PLATE LXXII. FIG. 4 *a*, *b*.

The specimen is a cast, consisting of about eleven chambers. The septa are more distant and less convex than in *O. longicameratum*, and the shell more robust.

Fig. 4 *a*. The fragment, which is somewhat flattened from pressure.

Fig. 4 *b*. A section showing the subcentral position of the siphuncle.

Geological position and locality. In the central portion of the Lower Helderberg group : Schoharie.

Orthoceras pauciseptum (n. s.).

PLATE LXXII. FIG. 5 *a*, *b*.

SHELL cylindrical, very gradually tapering : septa extremely distant : siphuncle excentric. Surface unknown.

The specimen is a fragment, remarkable for the deep chambers which distinguish it from any other species in this geological period.

Fig. 5 *a*. A fragment of this species. The lower chamber is cut longitudinally, to show the place of the siphuncle.

Fig. 5 *b*. Transverse section, showing the excentric position of the siphuncle.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Schoharie.

PTEROPODA [?].

THE strata of the Lower Helderberg group have furnished two species of CONULARIA which appear to be distinct from any in the preceding formations. The CONULARIÆ, however, like all the phosphatic fossils, offer so little variety of form and surface ornament that the different species are not readily distinguished*.

Conularia pyramidalis (n. s.).

PLATE LXII A. FIG. 1 *a* – *d*.

SHELL pyramidal, quadrangular, length about two and a half to three times the width at the base; apex rounded, smooth; sides a little convex; sulci at the angles narrow, abrupt, a faint longitudinal depression along the middle of each side; transverse ridges bending upwards towards the angles, very slightly near the base and more abruptly towards the apex, continuous across each face, being slightly depressed in the middle, and meeting at the longitudinal suture at about the same angle as in the middle of each side; about fifteen or sixteen in the space of three lines, sometimes more crowded at intervals near the base; intermediate spaces marked by longitudinal striæ, of which there are more than twice as many, in an equal space, as of the transverse ridges: crests of the transverse ridges marked by short nodes or granules at the junction of the longitudinal striæ.

This species resembles the *C. trentonensis* in general form; but the transverse ridges and longitudinal striæ are generaliy finer in that species, which, however, presents considerable variation in these characters.

Notwithstanding that several of the specimens are broken across, they do not show any septa or other internal divisions; and the two specimens from the Trenton

* That the phosphatic shells exhibit so little variety, compared with the calcareous shells, is a fact that presents an interesting analogy to the few modifications of mineral forms in the phosphates, and the great multiplicity of form in the carbonates, of lime.

limestone, which show this character, are the only ones yet observed. The present species differs conspicuously from the Niagara species.

Fig. 1 *a*. A compressed specimen, which is entire at the apex.
In two individuals preserving the smooth apex, one of them seems to be perforated in the centre; but this feature may be accidental.

Fig. 1 *b*. A broken specimen, which preserves the quadrangular form of the shell.

Fig. 1 *c*. Enlargement of the surface as it usually appears under a lens.

Fig. 1 *d*. An enlargement of the surface, showing the granulose transverse ridges where the shell is entire. This character is rarely well preserved.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Albany and Schoharie counties.

Conularia huntiana (n. s.).

PLATE LXII A. FIG. 2 *a*, *b*.

SHELL elongate, very gradually tapering, sides rounded, angles somewhat deeply sulcate; centre of each side marked by a shallow longitudinal impression : transverse ridges curving into the sulci of the angles, and angularly bent on the middle of each side; about eleven in the space of three lines, the intermediate depressions marked by longitudinal striæ which are nearly twice as many in the same distance, or eighteen to twenty in the space of three lines.

The surface of the only known specimen of this species is exfoliated, so that its characters are not fully preserved. It differs from the preceding in its greater size and more gradually tapering form, as well as apparent greater convexity of the sides; while the comparative features, as shown in the transverse and longitudinal striæ, are quite distinct.

Fig. 2 *a*. Figure of the specimen, which is compressed.

Fig. 2 *b*. An enlargement of the surface, showing the bending of the transverse ridges at the sulcus on one of the compressed edges of the specimen, and their course across the centre of one side; with the longitudinal striæ. (The figure is enlarged in the same degree as that of the preceding species.)

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Schoharie county.

ARTICULATA.

ANNELIDA.

With the exception of the Tentaculites, which are arranged with the Crinoideæ, I have no examples of authentic Annelida beyond the single species of Spirorbis figured on Plate liv. The obscure trails or tracks sometimes noticed in the lower part of the group are not sufficiently characteristic to be of value in the determination of the strata, or to furnish any reliable information regarding the animals which produced them.

Spirorbis laxus (n. s.).

Plate LIV. Fig. 18 *a* – *e*.

Shell discoid or spirally ascending, dextral, consisting of about three volutions (varying from two and a half to four), which are conspicuous on the upper side, and partially exposed in a deep umbilicus : tube round, gradually enlarging towards the aperture; aperture round, often turned at right angles to the spire, and sometimes a part of the last volution, or the entire volution, is quite free and extended in the same manner, having a slightly spiral direction.

Surface marked by strong annulating ridges, and by finer striæ in the spaces between.

This species assumes a considerable variety of appearance; but the numerous gradations between those having all the volutions contiguous, and those where the last volution is entirely free, leave no doubt that all the varieties observed are of a single specific form. The transverse ridges are usually conspicuous, but these sometimes appear as closely arranged lamellose striæ. The finer annulating striæ are only visible under a strong lens, and there are sometimes indications of fine spiral lines.

Fig. 18 *a*. A fragment of stone, preserving numerous individuals of this species.

Fig. 18 *b*. The upper side of the spire of a specimen, greatly enlarged.

Fig. 18 *c*. The lower side, showing the round mouth and the umbilicus.

Fig. 18 *d*. A specimen in which the last volution is free. (This is a common condition of the species)

Fig. 18 *e*. A specimen in which the apex is closely involved, and the remaining portions not contiguous. (This is an extreme form, and rarely seen.)

Geological position and locality. In the tentaculite limestone, base of Helderberg mountains : Schoharie, Carlisle, and other places.

CRUSTACEA.

The Crustacea of the Lower Helderberg group are not numerous; and though the collections have been continued in the Helderberg mountains, and at Schoharie and Carlisle as well as other places, through many years, the specimens that have been obtained are for the most part fragmentary.

The small number of individuals, of nearly all the species, which have been found, shows that they are comparatively rare in the localities examined. Two species, the *Dalmania pleuroptyx* and *D. micrurus*, occur in considerable numbers; mostly, however, preserving only the caudal extremity. After these, the *Phacops logani;* while the *Acidaspis tuberculatus* is of frequent occurrence in certain layers, but always in the condition of fragments.

The genera occurring in this group are Bronteus, one species; Proetus, one species; Homalonotus, one species; Phacops, one species; Dalmania, four species; Lichas, two species; Acidaspis, two species.

There are, besides the trilobites, several species of Beyrichia and of Leperdita.

Bronteus barrandi (n. s.).

Plate LXXIII. Fig. 1, 2, 3, 4.

Pygidium semielliptical; line of articulation straight; rudiment of the axis abruptly prominent, nearly twice as wide at its upper edge as the length, showing two articulations. Surface around the axis nearly plane, and thence sloping more abruptly, and again becoming nearly flat at the margin; marked by seven ribs on each side the median lobe, which is wider than the lateral ones and gradually narrowing from the base of the axis for one-fifth of its length, below which it gradually expands towards the border without bifurcating; its surface scarcely more prominent than the lateral ribs, and the furrows limiting it not more profound than the adjacent ones : lateral ribs narrow at their origin and gradually expanding towards the margin, the upper one wider at its outer extremity than either of the others.

SURFACE marked by undulating lamellose striæ, which are arched upwards on the ribs : intermediate spaces covered by fine granulations.

This species is closely related to the *B. partschi* and *B. nuntius* of BARRANDE; but the pygidium being the only part of our species which has been seen, a satisfactory comparison cannot be made. The surface marking, however, though more nearly resembling that of *B. nuntius*, is different from that of either of the Bohemian species.

Fig. 1. The pygidium of the natural size. (The specimen is imperfect, and the figure is completed from a cast of the impression in stone.)
Fig. 2. The impression of the same.
Fig. 3. Profile of the same.
Fig. 4. Enlargement of the surface, showing the undulating striæ and minute granulations.

Geological position and locality. In the pentamerus limestone of the Lower Helderberg group : Schoharie county.

Proetus protuberans (n. s.).

PLATE LXXIII. FIG. 5, 6, 7, 8.

ENTIRE form oblong elliptical. Head semicircular, very gibbous; the glabella very prominent, rounded in front, not distinctly lobed; the cheeks sloping abruptly from the eyes to the outer margin : posterior angles subacute (perhaps prolonged into spines in entire specimens); eyes prominent. Occipital annulation prominent; the furrow strong, and marked below each posterior angle of the glabella by a small tubercle.

THORAX consisting of nine or ten articulations (the specimen being too imperfect for actual determination). The axis is very prominent, semicylindrical, and the lateral lobes nearly flat for a little distance from their origin, and then bending abruptly downwards.

PYGIDIUM semicircular : axis very prominent, marked (in the cast) by eight annulations; lateral lobes marked by four or five ribs.

SURFACE granulate; the anterior border, and articulating surfaces of the axis, striate : exfoliated surfaces striate.

This species bears some resemblance to *P. bohemicus* of BARRANDE, but is proportionally narrower and the head is smaller. The specimens observed are a single

head, and another one preserving the head and part of the thorax and several articulations of the pygidium, and a separate pygidium; but the whole are so mutilated as to afford very unsatisfactory evidence of the entire character of the species.

Fig. 5. The head of this species.
Fig. 6. A fragment preserving the head and part of the thorax.
Fig. 6 *a*. Lateral view of the same.
Fig. 7. The pygidium of another individual.
Fig. 8. An enlargement, showing the surface marking.

Geological position and locality. In the pentamerus limestone of the Lower Helderberg group : Schoharie county.

Homalonotus vanuxemi (n. s.).

PLATE LXXIII. FIG. 9 – 14.

HEAD unknown.

THORAX long : sides subparallel, the middle lobe flattened on the exterior surface; articulations arching forward; longitudinal furrows faintly defined, being a simple undulation in the articulations; lateral lobes narrow, the articulations bent abruptly downwards at the sides.

PYGIDIUM subtriangular with the articulating side much longer and broadly curving, extremely convex : axis prominent in the young specimens, and becoming subdued in older ones; width, at its upper extremity, equal to that of each of the lateral lobes. Annulations fourteen or fifteen in the cast, and twelve ribs visible on each of the lateral lobes.

SURFACE of the test punctate and striato-punctate : cast punctate.

This species is known from three specimens of the pygidium (two of which are imperfect at the posterior extremity), and a fragment of the thorax; no specimens of the head having come under my observation. The thorax differs from the Niagara species in the forward arching of the articulations of the axis, while those of the lateral lobes are thicker towards their extremities.

The pygidium of this species differs from that of *H. delphinocephalus* in the lesser prominence of the base of the axis and its greater number of articulations, which are more distinct, and the lower margin of each one more abrupt; and while we have in the lateral lobes of the Niagara species six or seven, and rarely eight or nine ribs, there are in this species twelve, counting in both instances the upper one, which is usually covered by the last thoracic articulation.

Fig. 9. A fragment of the thorax of a specimen of medium size.
Fig. 10. The pygidium of a small specimen.
Fig. 11. Profile view of the same.
Fig. 12. The pygidium of a large individual.
Fig. 13. An enlargement of the surface.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg mountains, Albany county, and in Herkimer county.

Phacops logani (n. s.).

PLATE LXXIII. FIG. 15 – 25.

GENERAL form elliptical. Head semicircular in outline, broadly concave above, with the posterior angles curved and declining more abruptly. Glabella somewhat pentagonal; length and greatest breadth nearly in the proportion of three to four; very prominent in front, projecting beyond the rudimentary frontal limb, which becomes more developed on each side, and below which is a defined groove, marking the limits of the lower side of the cephalic test. Upper surface convex, gibbous in front, having two pairs of transverse grooves, the middle and posterior ones of which are but faintly defined; while the third or anterior ones, extending from the inner angle of the eye backwards and a little inwards, are scarcely conspicuous, and, on many specimens, not observable. First annular furrow strongly defined, and sometimes with a small tubercle at the summit : first or intercalated annulation narrow and well defined, and terminated at each extremity by a strong oblong tubercle, which is wider than the annulation, and usually marked by two pustules at the summit, one on each side of the centre. Occipital furrow wider and more strongly defined than the intercalated one, slightly sinuous, and terminating in a deep cavity at each extremity : occipital annulation broad and strong, slightly sinuate at the extremities, and, when entire, marked by one larger central pustule and several smaller ones.

Eyes of medium size, their summit less elevated than the glabella, extending backwards to the line of the occipital furrow, composed of seventeen vertical ranges of lenses; the entire number of lenses in full-grown specimens about one hundred, and varying in the specimens examined from ninety-three to one hundred and three.

The axis of the thorax is prominent, and narrower than each of the lateral lobes; the annulations furnished with a prominent node at each extremity. The lateral lobes are flat or somewhat concave towards the axis, the articulations bending abruptly downward from the middle towards the extremities; each articulation strongly grooved, the groove extending beyond the curvature.

Pygidium semicircular; the axis prominent, with about nine annulations; the lateral lobes having about five or six ribs, each with a groove along the centre.

Surface of the glabella pustulose, and of the articulations granulose, with some larger granules or pustules. The crust is thin, and the interior of the glabella shows distinct cavities corresponding to the external pustules. Hypostoma broad hastate; the buccal extremity obtuse, with a minute central point.

This species, after the *Dalmanites pleuroptyx*, is more common than any other trilobite in this group of strata. It is not unfrequently enrolled, though nearly all the specimens in this condition are imperfect. The separate heads, which best illustrate the characters of this portion of the animal, are from the decomposed shaly limestone.

This species resembles the *Phacops fecundus* of Barrande; but the eyes are smaller, with a less number of lenses, while the head is proportionally less broad, and there are fewer ribs in the lateral lobes of the pygidium. It differs from the *P. bufo* in the transverse furrows of the glabella, which in that one are rarely defined; in the characters of the eye; and in the prominence of the tubercles at the extremity of the annulations of the axis, as well as in the ribs of the pygidium, which are more bent backwards in this one. The crust of the thorax in the *P. bufo* is more finely granulate, and the axis less prominent.

Fig. 15. An entire specimen which has the head compressed from above, and the eyes a little distorted.

Fig. 16. View of a specimen which is enrolled.

Fig. 17. The head of a larger individual which shows the transverse furrows, and preserves the eyes in their proper form.

Fig. 18. A larger head, which has few pustules in the space between the eye and the dorsal furrow.

Fig. 19. Frontal view of fig. 17.

Fig. 20. Profile of the same.

Fig. 21. View of the lower side of the head of another specimen, showing some crenulations along the marginal furrow.

Fig. 22. The lower side of another specimen in which the granulation is worn from the surface of the glabella, and showing the line of the hypostomal suture.

Fig. 23. The eye enlarged.

Fig. 24. A portion of the eye, from which the lenses have been removed by weathering.

Fig. 25. The hypostoma.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Helderberg moutains, Catskill, Becraft's mountain, Schoharie, Carlisle, Cherryvalley, and other places.

Phacops hudsonicus (n. s.).

PLATE LXXIII. FIG. 26, 27, 28.

HEAD semielliptical, the length greater than half the width; the posterior angles scarcely extended, and slightly rounded.

GLABELLA subpentagonal; length nearly one-third greater than the width. Frontal lobe very prominent, gibbous above : middle and anterior transverse furrows distinctly impressed in the cast; first annular furrow faintly defined; first annulation not prominent, with two pustules at the summit and a node at each extremity : occipital furrow and annulation strongly defined. Cheeks triangular, not produced behind.

EYES small, extending backwards to the line of the first annular furrow, having an elevation of four ranges of lenses.

This species is founded on a single head (the test being removed from the glabella), which is more produced in front than the *P. logani* : the eyes are smaller, and not extending so far backwards.

Fig. 26. The head of this species.

Fig. 27. Profile of the same.

Fig. 28. The eye enlarged.

Geological position and locality. In the compact beds of the shaly limestone : Becraft's mountain, near Hudson.

This species has usually been referred to *Dalmania* (*Asaphus*) *hausmanni* by American and European authors; but a comparison with the excellent figures of BARRANDE, and with his minute description, shows a difference in form of the pygidium, which, in our species, is more triangular; in the prolongation of the posterior angles of the head; in the number of lenses in the eye (the European form having from 420 to 680); and in the articulations of the axis of the pygidium, which, in the *P. hausmanni*, has eighteen or nineteen, and thirteen or fourteen ribs in each of the lateral lobes.

PLATE LXXIV.

Fig. 1. A young specimen which is extremely flattened.

Fig. 2. The same enlarged, showing more distinctly the characteristic features of the species.

Fig. 3 & 4. The head of a young and of a half-grown individual, which are probably of this species. In the fragmentary condition of specimens, I have at present no means of knowing which of the heads may belong to this or to the succeeding species.

Fig. 5. The original preserves the central portion of the head, with one eye nearly entire. The posterior angles are completed from another specimen.

Fig. 6. The pygidium of a young specimen.

Fig. 7. The pygidium of a larger individual.

Fig. 8. A larger individual in which seventeen annulations are distinctly visible in the axis (and an eighteenth is very faintly indicated), and thirteen ribs in each lateral lobe).

Fig. 9. Profile of the head, showing the form and elevation of the eye.

Fig. 10. The eye enlarged.

Fig. 11. A portion of the surface still farther enlarged.

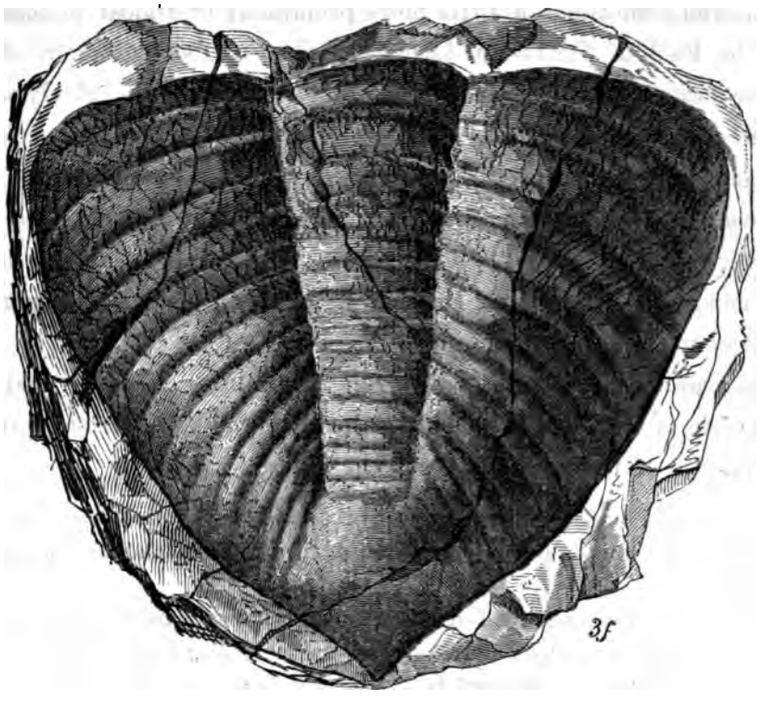
Fig. 12. A magnified portion of the eye, where the lenses have been removed by weathering.

PLATE LXXV.

Fig. 1. The specimen is a cast preserving a part of the head, the axis and one lateral lobe of the thorax, and a part of the pygidium. From the condition of the specimen, it cannot be positively referred to this species, though there can be little doubt of its identity.

Geological position and locality. In the shaly limestone, and sometimes in the pentamerus limestone, of the Lower Helderberg group : Helderberg mountains, Schoharie, Carlisle, Catskill and Becraft's mountain, and in the same geological position in Pennsylvania and Virginia.

The accompanying figure is from the mould of a pygidium, in the axis of which about fifteen articulations may be counted, the posterior ones being obliterated. It is evidently the pygidium of one or the other of these species, and, from its great breadth, I am inclined to refer it to *D. pleuroptyx*. It is interesting as showing the large size to which the animal has sometimes attained.



DALMANIA PLEUROPTYX.

Dalmania micrurus.

PLATE LXXV. FIG. 13 – 18.

Asaphus micrurus : GREEN, Monograph, p. 56, Cast No. 19, f. 3.
Asaphus hausmanni, in part, of authors.

PYGIDIUM triangular, convex, somewhat abruptly sloping at the sides, acute, attenuate behind. Axis very prominent, faintly subangular in the middle above, and regularly rounded towards the posterior extremity, rigid, scarcely declining below, and abruptly elevated from the posterior marginal border; a narrow angular ridge extending from the extremity of the axis into the acute spiniform caudal termination.

THE number of articulations in the axis is twenty or twenty-one, which are strongly defined, and some of the anterior ones slightly bent for-

ward, and sometimes a little more prominent or almost nodose in the middle. Each of the lateral lobes is marked by fourteen or fifteen (and, in one example, sixteen) ribs; the anterior ones very regularly arching, while about four or five of the posterior ones are turned backwards, approaching the parallel of the axis. Each rib is marked by a narrow groove along its summit, continued to where the ribs coalesce in the narrow marginal rim. The direction of this suture, near the origin of the ribs, is a little below the middle, but, in its course, approaches more nearly the upper margin.

SURFACE granulose, with a row of stronger granules or small pustules on each side of the furrow marking the ribs, and still stronger ones on the middle of the annulations of the axis.

I have a single head which is more convex, and the frontal lobe of the glabella more prominent than those referred to the preceding species, and which may belong to this one.

Until recently, I had regarded the numerous specimens of the pygidium occurring in the pentamerus and shaly limestones of the Helderberg group as belonging to one species, presenting some variety in the number of annulations; but a comparison with the original specimen of *D. micrurus* described by Dr. GREEN, shows that it has a more rigid aspect, is less curved outwards, and is proportionally narrower on the posterior half of the pygidium, and the axis is proportionally longer and more rigid; while in specimens which have not suffered pressure, the sides are more abruptly bent downwards to the margins. These forms, whether large or small, have shown usually twenty articulations of the axis and fourteen or fifteen ribs in the lateral lobes, without any evidences of gradation in number which would unite the preceding species.

Dr. GREEN describes the original as having "eighteen articulations of the tail and abdomen." The specimen, which is a cast, measures more than two inches in length*, and has the first narrow articulating ring obliterated, while the posterior part of the axis is so much worn as to obscure the annulations. At the same time twenty annulations may be traced, and there has probably been one more; while there are sixteen ribs on one side, and on the other side two of the anterior ribs are broken off.

The species is cited by Dr. GREEN as from Trenton falls; but not only is the limestone of a different character, but the associated fossils prove very satisfactorily

* "Length, two inches and a half." Monograph, p. 57.

the geological position of the specimen to be in the Lower Helderberg group; while a similar specimen, though less perfect, in the same collection (that of the Albany Institute), is marked as from the Helderberg mountains, Albany county.

Fig. 13. The pygidium of a young specimen, contrasting with fig. 6 in the number of annulations of the axis and ribs in the lateral lobes.

Fig. 14. A small pygidium having fifteen ribs on each lateral lobe, and twenty annulations of the axis.

Fig. 15. A fragment of a similar pygidium, on which the test is very perfectly preserved.

Fig. 16. A larger pygidium from which the test has been removed, leaving the cast punctate.

Fig. 17. Profile view of the same.

Fig. 18. An enlargement to show the surface markings, from fig. 15.

Geological position and locality. In the pentamerus and shaly limestones of the Lower Helderberg group : Albany and Schoharie counties.

Dalmania tridens (n. s.).

PLATE LXXV. FIG. 3, 4, 5 & 6.

This species is known only from some fragments of the head, which show the lower side of the test : one specimen preserves the cavity of the eye and the lower side of the glabella. The frontal process is strong, somewhat flattened and trifurcate at the extremity; the divisions short and strong. The surface of the frontal process is evenly granulose, the under side of the glabella showing marks of larger pustules. The specimens present some variety in the extension of the frontal process, but which does not appear to be of specific importance.

This species differs essentially from *D. tridentifera* of SHUMARD (Missouri Geological Report, 1855, Part II, pa. 199, pl. B, f. 8 *a*, *b*), in the extension of the frontal process.

Fig. 3. The under side of a portion of the head, showing the cavity of one eye and the extension of the frontal process.

Fig. 4. A fragment of the lower surface, showing the marginal limb on one side and the frontal process. The abruptness of the junction of the process with the marginal limb, as represented in the figure, is due to an imperfection in the specimen at that point.

Fig. 5 & 6. Fragments of the marginal limb and the frontal process from the lower side, with portions of the surface enlarged.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Schoharie.

Dalmania nasutus.

PLATE LXXV. FIG. 2; and PLATE LXXVI. FIG. 1 – 9.

Asaphus nasutus : CONRAD, Annual Report on the Palæontology of New-York, 1841, p. 48.

Mr. CONRAD has given the following description of the species cited above :

"BUCKLER rostrated : ribs with a wide shallow sulcus; a few of the ribs
" each with a large tubercle; two rows of tubercles on the middle lobe,
" obsolete on some of the ribs. Tail consisting of a long, round, finely
" tuberculated spine."

To which may be added :

HEAD crescentiform, with the posterior angles extended into long mucronate points, and the frontal limb projected into a broad and somewhat flattened spiniform process which is bifurcated at the extremity.

GLABELLA moderately convex; length from the occipital furrow to the anterior margin about one-fourth greater than the width of the frontal lobe, which is transversely oval, being about three-fourths as long as wide; transverse furrows strongly marked, the anterior and central ones not strongly marked across the middle : anterior lobes broad and prominent, widening towards the eyes, the middle ones of nearly the same width throughout; the central space between the inner extremities of the anterior and middle lobes nearly flat : posterior lobes a little pointed forwards in the middle. Occipital furrow shallow, its continuation in the posterior furrow of the cheeks being wider and deeper.

EYES large and prominent, the outer rim much elevated above the central portion : a strongly marked furrow around the base, which separates it from the adjacent surface of the cheek. Entire number of ranges of lenses, laterally, about forty, which, in the highest part of the eye, have an elevation of ten or twelve lenses; the entire number between 350 and 400 (no specimen being sufficiently perfect to count them all).

Area between the lenses marked by a small round granule at each angle of a hexagon which circumscribes the lens.

Hypostoma hastate; central portion somewhat transversely lobed, the points of muscular attachment strongly marked : lateral border sinuate, with a short central process at the extremity and three similar shorter ones on each side. Thorax unknown.

Pygidium somewhat triangular, with the sides and articulating face curved, the posterior extremity produced in a long slender spine : surface broadly convex. Axis prominent, gradually attenuate; width at the upper extremity more than half as great as the lateral lobe, marked by about sixteen or seventeen annulations, the posterior ones of which are subangular in the middle, and the anterior ones marked by a node on each side of the centre. Lateral lobes marked by about twelve or thirteen ribs, which are wider than the spaces between : ribs marked by a narrow longitudinal groove, which, beginning nearer to the lower side, runs a little diagonally, so that at a point half the length of the rib it is nearer the upper margin, and continues thence parallel to the margins till the rib and groove are merged in the thickened border. Each of the ribs, about half way from the axis to the margin, is bent a little more suddenly downwards, rising again beyond so as to leave a shallow depression parallel to the outer margin, the limits of which are more or less distinctly marked by a node on one or both sides; and when there is no distinct node, there is usually a thickening of the rib at the same point. Sometimes there is a line of nodes only on one side of the depression in the ribs. These nodes, when developed, interrupt the longitudinal groove of the rib. The spine at the posterior extremity, as measured in one specimen which appears to be entire, is about once and a half as long as the pygidium.

Surface of the head, annulations, ribs and marginal limb of the pygidium pustulose, with intermediate finer granulose markings; the spine somewhat more coarsely granulose.

This species is remarkable both for the bifurcate rostration in front of the head, and for the long posterior spine. The test is perhaps a little thicker than that of

either of the preceding species except *D. tridens*, and may usually be distinguished, particularly on the border or limb, by its coarser pustulose markings.

Two specimens have been found partially preserving the bifurcate extension in front, one being the upper and the other the lower side of the head; while two others (one of which is represented, fig. 1, Plate LXXVI) have this process broken off. In one specimen, a single eye is pretty well preserved, but not in such a degree of perfection as to enable one to count the entire number of lenses.

PLATE LXXV.

Fig. 2. The inner side of the crust of a pygidium, showing the thickened border and a part of the posterior spine.

PLATE LXXVI.

Fig. 1. The head of a specimen, natural size. The frontal process is broken off; and the continuation, as represented, is drawn from fig. 2.

Fig. 2. An imperfect head preserving the glabella (which is distorted by pressure), the bases of the eyes, and the frontal process. The extremities of the bifurcations are broken off, and their true extent is not known.

Fig. 3. The under side of the test of the head, preserving the anterior border and the frontal process.

Fig. 4. The eye and part of the cheek, from another specimen.

Fig. 5. Profile view of the same, with the posterior portion extended.

Fig. 6. A portion of the eye-surface enlarged, showing the lenses and the rounded grains between.

Fig. 7. The pygidium, showing the elongate caudal spine.

Fig. 8. Profile view of the same.

Fig. 9. Enlargement of the surface.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Schoharie.

Lichas bigsbyi (n. s.).

PLATE LXXVII. FIG. 1 – 8.

HEAD abruptly arched, the anterior contour parabolic; frontal limb narrow, with a strongly defined groove. The median lobe of the glabella ventricose anteriorly and in the middle, narrowed and somewhat depressed behind, becoming nearly flat towards the occipital furrow; width, in front, four times as great as at the base; rising very prominently above the other parts of the head, the greatest elevation about half way from the occipital furrow to the frontal margin. The anterior

lateral furrow passes inwardly from the anterior margin to the narrower part of the median lobe, whence, for a short distance, it is nearly parallel to the axis, and then diverges abruptly towards the occipital furrow. The median furrow is essentially parallel to the anterior lateral one; leaving the anterior lateral lobe with parallel sides, a moderately arched outline, and having a length about three times as great as the width. The occipital furrow is a well-defined semicircular groove, showing a transversely oblong slightly elevated tubercle just behind the posterior lateral lobe. The occipital annulation is twice as broad as the furrow, and moderately convex. The entire head is covered by small rounded pustules of unequal size.

A separate hypostoma, found in the same strata and presumed to belong to this species, has a width about one-fourth greater than the length; the central portion very broadly ovate, and its margin deeply indented below the middle by two oblique sharply impressed furrows, the anterior portion being transversely oval. The lateral borders are broad, and the buccal border deeply notched. The surface of the anterior portion is finely pustulose.

A fragment of a pygidium, found in the same beds, preserves one side with a portion of the axis. The axis, in its upper part, is abruptly elevated, but its comparative height cannot be determined. The ribs are broad, and distinctly grooved longitudinally a little in advance of the centre. As far as can be ascertained, the axis is contracted a little in advance of the middle of its length and expands again below, the extremity being probably bifurcate. The surface is pustulose, a single row of larger pustules marking centrally each lobe of the ribs.

Fig. 1. Profile view of an imperfect head. The median lobe of the glabella is not represented as sufficiently prominent.

Fig. 2. View of the upper side.

Fig. 3. Anterior view, showing the elevation of the median lobe and the frontal limb. The surface is represented as too coarsely pustulose.

Fig. 4. View of the upper side of the head. The median lobe of the glabella is not sufficiently narrowed in its posterior part. The surface markings in this figure present the prevailing feature.

Fig. 5. The median and anterior lateral lobes of the glabella of a larger specimen, which is somewhat depressed.

Fig. 6. Profile view of the same.
Fig. 7. The hypostoma.
Fig. 8. A part of the pygidium of this species.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Coeymans, Schoharie and Carlisle.

Lichas pustulosus (n. s.).

PLATE LXXVII. FIG. 9 – 12; and PLATE LXXVIII. FIG. 1 – 7.

HEAD extremely ventricose : the limb is of moderate thickness, slightly recurved, leaving a comparatively broad shallow groove; margin of limb pustulose. The posterior margin of the head is moderately convex; the occipital furrow well defined, but not deep.

The median lobe of the glabella is extravagantly elevated, standing out like a distinct protuberance in advance and above the interior lateral lobes : the form at the base is broadly ovate, gently narrowing behind for a little more than half its entire length to its greatest elevation, and, then abruptly declining and contracting, becoming almost flat between the anterior lateral lobes; showing a crest at the margin of the occipital furrow. The length and greatest breadth of this lobe are about equal, and the elevation from the frontal limb to the summit of the lobe is nearly equal to the width at the base in front. Anterior furrow shallow in front, becoming more defined in its posterior direction, and, at the inward curving of the protuberant part of the median lobe, is very strongly defined, while in the posterior part it is scarcely below the plane of the central part of the median lobe. Anterior lobe oblong, narrow and depressed in front, gradually rising, spreading out and becoming protuberant behind. Entire surface pustulose; the pustules prominent, of various sizes, sometimes rising to the form of short spines.

Two fragments, found in the same association, appear to be the movable cheeks of the species : the lower side only is visible, and the marking is similar to that on the lower side of the pygidium.

Fig. 5. A fragment of the pygidium, where the posterior part of the axis is extremely prominent, and the bases of the principal and smaller lateral spines are preserved. The continuation of the ribs is preserved only in outline.

Fig. 6. The underside of a part of the pygidium, showing the thickened border, the sharp elevations separating the ribs, and those marking the furrow upon them. The round pits indicate the bases of the large tubular spines, which ornament the surface with some regularity.

Fig. 7. The lower side of a pygidium, showing the broad thickened border, and the deep cavity made by the protuberance at the extremity of the axis. The bifurcations of the central lobe are more diverging than usual, but this feature is accidental in the specimen.

Geological position and locality. In the limestones of the Lower Helderberg group: Albany and Schoharie counties.

Acidaspis tuberculatus.

PLATE LXXIX. FIG. 1 – 14.

Acidaspis tuberculatus : CONRAD, Annual Report on the Palæontology of New-York, 1840, p. 205.
Acantholoma : CONRAD, Ibid. idem.
Acantholoma spinosa : CONRAD, Ibid. 1841, p. 39.

HEAD somewhat semicircular, convex, with the posterior angles greatly extended : length about one-third the entire length of the animal. The frontal border is nearly straight, and bears on its upper margin a row of pustules; separated from the glabella in the middle of the front by a shallow groove, which becomes much deeper towards the lateral angles.

Median lobe of the glabella oblong, spreading in front and becoming somewhat semicylindrical behind, giving a subclavate form. The two lateral lobes are small oblong tubercles, separated from each other and from the median lobe by a defined furrow, which is very deeply impressed at the anterior inner side of each of the lateral ones. Occipital furrow broad and shallow in the middle, and depressed in a deep pit just behind each of the posterior lateral lobes of the glabella. The occipital annulation is well developed, and, in the centre, produced into a short strong spine, which is slightly ascending and projecting backwards.

The cheeks (known only in a separated condition) are triangular; the inner angle being occupied by the eye tubercle, and the anterior one

joining the frontal border, and forming with it a continuation of a similar border; the pustules, as they recede from the centre in front, gradually become stronger and assume the form of short spines, which, to the number of ten to fourteen, ornament the cheek border. The posterior angle is produced in the form of a long curving spine, on the inner margin of which, beyond the limits of the head proper, are one, two, or three short spines.

Eyes nearly in a line with, or a little in advance of, the occipital furrow, subcylindrically ovoid; showing, under a lens, the minute facets upon the surface.

The thorax (imperfect) has apparently nine segments : the axis is very prominent, and nearly one-third narrower than the lateral lobe; the articulations marked by a node at each extremity, and one in the centre : lateral lobes of the axis having the articulations produced into a long rounded spine, which is bent abruptly backwards, and finally assumes a direction nearly parallel to the axis; each of the articulations marked by two strong nodes, one of which is at the point of retrorse bending of the rib, and the other nearer to the axis. The prolongation of the spine is two and a half to three times as great as the width of the lateral lobe.

Pygidium, excluding the spines, somewhat semicircular, preserving three annulations in the axis, and marked posteriorly by a strong elevated rim. From the middle segment are produced two long spines at right angles to its direction, or parallel to the axis, and, between these, two shorter intermediate spines; while on each side, exteriorly to the long spines, are three others : the inner one is essentially parallel to the long spines, while the outer ones are divergent, and originate in a bifurcation of the rib. The middle annulation is marked by three nodes in its central portion; while the long spines each have two strong nodes near their origin, and similar smaller nodes mark the origin of the outer spines. The posterior segment has two small nodes on each side, with the centre plain.

SURFACE granulose, the lobes of the glabella being unequally pustulose.

This species usually occurs in fragments; a single specimen only preserving the parts in connection, and this one is too imperfect to afford the means of description. The description is drawn from isolated parts, which are represented on the plate. The fossil described by Mr. CONRAD as *Acidaspis tuberculatus* was the central portion of the head, preserving the central posterior spine, while the separated cheeks were described as *Acantholoma**.

In certain shaly layers the fragments of this species are quite common, the separated cheeks being the most conspicuous parts.

Fig. 1. View of a specimen preserving the members in connexion; but the fossil being imbedded in a hard stone, the condition does not admit of the parts being shown in detail.

Fig. 2. The central portion of the head, showing the lobes of the glabella, the frontal border, the occipital annulation, and the central posterior spine.

Fig. 3. The central part of the head of another specimen.

Fig. 4. Profile of the same.

Fig. 5. A portion of the surface enlarged.

Fig. 6 & 7. The right cheeks of two different individuals, preserving the eye tubercle, and showing differences in the exterior and inner spines.

Fig. 8. The left cheek, which shows very distinctly, as do the others, the gradation of the border ornaments, from small nodes at the anterior extremity, to distinct spines.

Fig. 8 *a*. A cheek, with the eye tubercle, enlarged.

Fig. 9 & 10. The underside of two cheeks, one of which shows a single spine on the inside, and the other a single spine with the rudiments of two others above it.

Fig. 11. An articulation of the thorax.

Fig. 12. The underside of a part of the thorax, showing the extension of the lateral spines of the articulations.

Fig. 13. The pygidium, in which the upper lateral spine is not preserved.

Fig. 14. The pygidium of another individual, showing the parts described.

Geological position and localities. In the shaly limestone of the Lower Helderberg group: Albany and Schoharie counties.

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* Our knowledge of the Genus ACIDASPIS, at that period, was derived from the figures of some parts of the animal in MURCHISON's Silurian System. These remarkable appendages did not correspond with any recognized parts of the *Acidaspis*, as known at that time.

Acidaspis hamata.

PLATE LXXIX. FIG. 15 – 19.

Genus DICRANURUS : CONRAD, Annual Report Palæontology of New-York, 1841, pa. 48, pl. f. 1.
Dicranurus hamatus : CONRAD, Idem; Catalogue, p. 39.

HEAD subrhomboidal in the central part, nearly straight or slightly curving in front. Median lobe of the glabella moderately gibbous, depressed and narrower in front, gently rising and slightly widening posteriorly. The anterior lateral lobes are low oblong tubercles, separated by an almost direct longitudinal furrow from the median lobe, and by a direct transverse furrow from the posterior lateral lobe, which is a low round tubercle. Occipital furrow well defined behind the median lobe, curving a little backwards around the base of the posterior lateral lobe : occipital annulation well defined, with a short tubercle in the middle, and projecting behind in two long, slightly diverging, recurved spines. Surface pustulose, with the intermediate spaces granuliferous.

THORAX [of this species?] with the axis very abruptly elevated, semicylindrical; the articulations of the lateral lobes extending at right angles to the axis, and thence curving gradually for a short distance, when they turn abruptly backwards, extending into a long round spine. Surface of articulations coarsely granulose, without distinct tubercles.

The central portion of the head, with the recurved spines from the occipital annulation, is the *Dicranurus* of CONRAD. From the form of the glabella and surface characters it is clearly an *Acidaspis*, resembling in some degree the *A. monstrosa* of BARRANDE.

The few articulations of the thorax found in a separate specimen are not positively known to belong to this species, but differ very strongly from the A. *tuberculata*; and since we know of no remains of other species in this rock, they are probably of this one.

Fig. 15. A small individual preserving the central portion of the head and the occipital spine.
Fig. 16. A larger individual. Fig. 17. Profile view, showing the recurved spines.
Fig. 18. The bifurcating occipital spine of a larger individual.
Fig. 19. A fragment of the thorax, probably of this species.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Albany and Schoharie counties.

The following species of Entomostraca have been recognized in this group* :

Leperditia jonesi (n. s.).

PLATE LXXIX A. FIG. 5 *a* – *e*.

Leperdita (Cytherina) alta? Palæontology of New-York, Vol. ii, pa. 331, pl. 78, f. 2.

CARAPACE large : valves strongly convex, gibbous in the middle; anterior end narrower, rounded; posterior end broadly and regularly rounded; ventral margin broadly arching and abruptly incurved. The dorsal angles are expanded, and a distinct narrow border extends thence along the anterior and posterior ends, to where the ventral margin begins to curve inwards. The anterior tubercle is distinctly prominent, and above a line extended from the central tubercle to the anterior dorsal angle. Central tubercle moderately prominent, and distinguishable by the reflection of light upon the surface, the greatest convexity of the valve being posterior to the middle. Surface papillose. In casts, the place of the central tubercle is seen, with the radiating vessels distinctly visible in meandering granulose lines extending towards the posterior and ventral margins.

This species resembles in form the *L. alta*, and I had not originally separated it from that species. It differs, however, in its usually larger size and somewhat greater proportional breadth, while the papillose surface of the last is always a reliable feature for distinguishing it from that species. In specimens of the same size, it is more convex in the middle than *L. alta*.

Fig. 5 *a*, *b*. A young and medium-sized specimen, natural size.
Fig. 5 *c*. A full-grown specimen, natural size.
Fig. 5 *d*. Profile view of the same.
Fig. 5 *e*. An enlargement of the surface, showing the papillose markings.

Geological position and locality. In the coralline limestone, Schoharie, and in the same position in Herkimer county.

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* The *Leperditia jonesi* is introduced in this place, to correct the erroneous reference of the species in Vol. II.

Leperditia alta.

PLATE LXXIX A. FIG. 6 *a* – *e*.

Cytherina alta : CONRAD. VANUXEM, Geological Report of the Fourth District, 1843, p. 112, f. 6.

CARAPACE subreniform : valves strongly convex, gibbous in the middle, somewhat variable in their proportions, straight above and broadly rounded below, the extremities obliquely rounded, the dorsal angles varying in their degree of development; posterior side broader than the anterior : ventral margin of the right valve abruptly incurved, sometimes leaving an apparently obtuse carination along the line of bending. Anterior or eye tubercle distinct in the test, and sometimes distinct in the casts : not unfrequently there is a little inequality of surface between the anterior tubercle and the anterior dorsal angle. Central tubercle a gibbous area, not defined on the exterior surface, but from which, in casts and partial casts, the internal vessels are seen to radiate.

The anterior edge often presents a slight marginal rim, but this is rarely seen on the posterior border of the specimens before me. The ventral edge of the right valve is abruptly incurved over the edge of the left valve, and its inner margin shows two or three fine concentric lines and numerous fine crenulations; while the inner edge of the dorsal margin shows similar crenulations, which are perhaps a little stronger than those on the ventral side. The ventral margin of the left valve is bent inwards almost rectangularly to the axis; the included surface, or that covered by the right valve, limited by a thin sharp slightly elevated ridge; while on the anterior and posterior margins, the space between this ridge and the inner edge of the valve is contracted to a narrow well-defined groove. In older shells, the inner ventral edge of the right valve presents a strong groove for the reception of the ventral edge of the left valve.

SURFACE essentially smooth, or so finely granulose as not to be visible

under an ordinary lens. The test shows a tendency to decompose in minute points or punctations, which, beginning sparsely over the surface, finally cover it entirely, even in unweathered specimens; while other specimens, which have been long weathered, present only scattered puncta.

When I described the species from the Coralline limestone, I had no specimen of *Leperditia alta* with well-preserved surfaces, and referred it with doubt to that species; but a comparison of the perfect test of the two species shows a well-marked difference. There are, moreover, in the same rock with the larger specimens of *L. jonesi* in the Coralline limestone, small specimens which are scarcely distinguishable from *L. alta*, but which, under a lens, show the papillose markings.

This species is extremely abundant in the Tentaculite limestone, literally covering some of the layers, in the planes of bedding, for many feet in extent, and more or less abundantly scattered through the entire formation to the base of the Pentamerus limestone, in which rock it is of rare occurrence. In its geographical distribution, it is known to extend everywhere in New-York where the Tentaculite limestone occurs, and is as abundant in Herkimer county on the south side of the Mohawk, as it is along the west side of the Hudson in the Helderberg mountains, Schoharie and Catskill.

Mr. T. Rupert Jones, F.G.S., has described some specimens from the shores of Wellington channel, which he refers with doubt to this species*. The condition of his specimens resembles that of the greater part of our own; and while his fig. 7 *a* resembles ours in form, the fig. 6 *a* is proportionally broader than any specimens of *L. alta* observed in our rocks.

Fig. 6 *a*. View showing the form of a specimen of ordinary size.
Fig. 6 *b*. The same enlarged two diameters.
Fig. 6 *c*. Profile view.
Fig. 6 *d*. The left valve of the same.
Fig. 6 *e*. The interior of the right valve. The larger figure surrounding it shows the crenulations of the dorsal line, and the groove in the ventral margin.

Geological position and locality. In the tentaculite limestone : Albany, Schoharie, Greene, Herkimer, Oneida and Cayuga counties, in numerous localities.

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* Annals and Magazine of Natural History, Second series, Vol. xvii, No. 98, p. 88.

Leperditia hudsonica (n. s.).

PLATE LXXIX A. FIG. 7 *a*, *b*, *c*.

CARAPACE valves nearly equal, slightly oblong, the length being to the width as three to two : hinge-line less than the greatest width, broadest at the posterior third; dorsal line straight; ventral and anterior extremities obliquely rounded, the posterior extremity broadly rounded, the anterior cardinal angle a little produced, and a narrow border extending a little below the dorsal line on each valve. The greatest convexity of the surface is central, or a little anterior to the centre, and not quite corresponding on the two valves. The antero-dorsal tubercle is but slightly developed, distant from the anterior extremity, and nearer the central tubercle : central tubercle not raised above the general convexity of the surface, and distinguishable only by the reflection of light. Ventral edge of the right valve curving over the edge of the left valve, which is abruptly bent inwards beneath the opposite valve, the limit of the included surface being marked by a sharp elevated line : substance of the valves thick.

SURFACE smooth, or without visible markings under an ordinary lens.

This species differs from *L. alta* in its greater proportional width and gibbosity: the anterior tubercle is proportionally more distant from the extremity; the ventral margin of the right valve is less abruptly bent inwards, and leaves no angle on the line of incurvation, which is less extended in this species, while the shell is thicker and the ventral margin more oblique.

Fig. 7 *a*. View of specimen, natural size.

Fig. 7 *b*. The same enlarged two diameters.

Fig. 7 *c*. Profile view, showing the nearly equal convexity of the two valves, and length of the hinge-line.

Geological position and locality. Near the base of the Lower Helderberg group : Becraft's mountain, near Hudson.

Leperditia parasitica (n. s.).

PLATE LXXIX A. FIG. 8 *a*, *b*.

CARAPACE minute, subreniform, subequivalved, the cardinal line a little concave in the middle; length about twice the width : ventral edge of the right valve a little oblique : anterior and central tubercles not conspicuous.

SURFACE smooth.

This species is extremely minute, and differs in its greater proportional length, and in the concavity of the cardinal margin.

Fig. 8 *a*. View of specimen enlarged ten diameters. Fig. 8 *b*. Profile view of the same.

Geological position and locality. In the shaly limestone of the Lower Helderberg group; attached to the surface of an *Orthoceras*.

Leperditia parvula (n. s.).

PLATE LXXIX A. FIG. 9 *a*, *b*.

CARAPACE minute, ovoid, gibbous, the anterior end much narrower than the posterior; posterior end regularly rounded : ventral margin of the right valve much thickened, and overlapping the left valve; hinge-line straight.

SURFACE minutely punctate (perhaps from weathering).

This species is scarcely more than half as large as *L. parasitica*, while its proportions of length and breadth are very different. It occurs on the surface of specimens with *Beyrichia notata* and *B. trisulcata*, *Spirorbis*, etc.; and its occurrence was first pointed out to me by Mr. WHITFIELD.

Fig. 9 *a*. A specimen enlarged ten diameters.
Fig. 9 *b*. Profile showing the thickened overlapping ventral margin of the right valve.

Geological position and locality. In the tentaculite limestone : Herkimer county.

BEYRICHIA.

I HAVE described a species of BEYRICHIA on page 317 of the second volume of the Palæontology of New-York, without referring to the authority for the generic name. The species, now constituting a very pretty and well-marked group under this name, were confounded with AGNOSTUS, till Professor M'COY discovered that instead of being a symmetrical trilobate crustacean, the lobes or divisions were unsymmetrical, and that the individuals were the separated "valves of a bivalve entromostracous shell".

The following is the description of Professor M'COY:

GENUS BEYRICHIA (M'COY).

Beyrichia: M'COY, Synopsis of the Silurian Fossils of Ireland, p. 57.
Agnostus and *Battus*, in part, of authors.

"SHELL bivalve, rotundo-quadrate: ventral margin slightly concave; "ends very nearly equal, obtusely rounded; sides equal, very gibbous, "deeply impressed by a strong and wide sulcus, which extends from "the ventral margin nearly to the dorsal, giving a bilobed or reniform "appearance to each valve. Sulcus slightly nearer to the anterior end: "within this sulcus, on each valve and close to the anterior (or smaller) "side, is a lengthened oval tubercle, nearly at right angles with the "ventral margin, and reaching about two-thirds the distance from "thence to the dorsal margin. Surface smooth [or granulose].

Beyrichia granulata (n. s.).

PLATE LXXIX B. FIG. 1 *a*, *b*, *c*, *d*.

RIGHT VALVE semielliptical, the anterior extremity scarcely narrower than the posterior: hinge-line straight, a little shorter than the greatest length across the middle of the shell. Anterior, posterior and ventral

margins bordered by a narrow rounded rim, which is separated from the body of the shell by a narrow groove. The anterior furrow is about halfway between the middle and the anterior end, extending halfway across the valve, curving a little backwards; while the posterior furrow is nearly central, extending about half the width of the valve, scarcely curving forwards, and not uniting with the anterior one. The space between the two furrows is occupied by a prominent node, which rises above the level of the surrounding surface.

SURFACE, except the furrows and base of the node, granulose.

This species is well marked in its regular form, nearly equal extremities, and beautiful granulose surface.

Fig. 1 *a*. The specimen, natural size.
Fig. 1 *b*. The same enlarged four diameters.
Fig. 1 *c*. Profile view of the same.
Fig. 1 *d*. A portion of the surface magnified, showing the granulose character.

Geological position and locality. In the pentamerus limestone of the Lower Helderberg group : Schoharie county.

Beyrichia oculina (n. s.).

PLATE LXXIX B. FIG. 2 *a* – *e*.

CARAPACE semioval, length little greater than the height, slightly contracted on the hinge-line : posterior furrow deep, nearly central, extending from the hinge-line more than halfway to the base, and curving slightly forwards; anterior furrow shorter and more shallow than the posterior, curving around the subcentral node above, but not reaching the hinge margin, and in its lower extension curving backwards and becoming more shallow, scarcely uniting with the posterior furrow. Posterior lobe sometimes with a transverse depression and the upper extremity becoming more prominent, and sometimes extending above the hinge-line, its entire width above being nearly equal to that below : anterior lobe depressed and narrower near the hinge-line, and spreading below. Body of the test separated from the inner border by a narrow groove,

which becomes less conspicuous on the ventral margin. Border sometimes scarcely marked on the ventral margin, and becoming wider above and subalate on the hinge extremities : ventral edge abruptly bent inwards with a distinct groove, which is wider in the centre and is discontinued at the anterior and posterior margins, allowing its two edges to come together, forming the thickened inner border which marks that part of the shell. Beyond these the entire margin is incurved, slightly thickened and crenulate, with a neatly defined groove just within it.

SURFACE finely punctate or striato-punctate.

This species differs from the preceding in being proportionally shorter, and in the greater prominence and inequality of the posterior lobe, as well as the lesser prominence of the ventral margin and the smoother surface.

Fig. 2 *a*. A specimen, natural size.

Fig. 2 *b*. The same enlarged four diameters.

Fig. 2 *c*. Another specimen, presenting some slight variations.

Fig. 2 *d*. Profile showing the elevation of the central and lateral lobes.

Fig. 2 *e*. Magnified view of the ventral margin and the ventral groove, with the outer groove and crenulated edge.

Geological position and locality. In the pentamerus limestone of the Lower Helderberg group : Schoharie county.

Beyrichia notata (n. s.).

PLATE LXXIX B. FIG. 3 *a*, *b*, *c*.

CARAPACE semioval, moderately convex, the length about once and a half the height, more or less symmetrical, the anterior end usually narrower than the posterior; marked by two transverse furrows, which reach about halfway from the dorsal to the ventral margin, the anterior one faintly curving backwards at the base. Middle lobe short, broad oval, reaching nearly halfway to the ventral edge : anterior lobe larger than the posterior, flattened at the antero-dorsal extremity. Ventral side gently incurved, bordered by a nearly flat rim which is straight in the middle of the base, and visible along the entire outline from the dorsal extremities : dorsal line straight.

SURFACE finely granulose.

This species presents some variety of form, more particularly in the relative proportions of the two extremities; some specimens being almost symmetrical, while others are much narrower on the anterior side. The individuals likewise vary in the degree of convexity; and while in well-marked specimens the middle lobe is not above the lateral ones, there are others where this lobe rises in a rounded node above the plane of the lateral lobes.

Fig. 3 *a*. The right valve of a symmetrical form of this species, enlarged four diameters.

Fig. 3 *b*. Profile view of the same.

Fig. 3 *c*. Figures showing some variety of form, as presented in a group of individuals upon the surface of a fragment of limestone : some of them are much more ventricose than others.

Geological position and locality. In the tentaculite limestone, and base of the shaly limestone of the Lower Helderberg group : Herkimer county.

This species is often extremely abundant, covering almost the entire surfaces of some layers of the rock.

The degree of variation in the forms which appear to be traceable to this species induces me to place the following as a variety of the same.

Beyrichia notata, var. ventricosa.

PLATE LXXIX B. FIG. 4 *a*, *b*, *c*.

CARAPACE unequally semielliptical, ventricose, the anterior extremity much narrower than the posterior : two short furrows mark the surface; the anterior one straight, and shorter than the other; the posterior one longer and slightly curving forward below, with a slight depression around the base of the middle lobe connecting the two grooves. Middle lobe consisting of a small oval tubercle, which does not reach the hinge margin. Posterior lobe narrow above, spreading and swelling out below, becoming quite ventricose and rounded on the ventral margin. Anterior lobe smaller and less ventricose, and separated on the ventral side by a slight sinuosity from the posterior lobe. Ventral margin incurved beneath the overspreading lobes, and appearing at the two extremities as a flattened rim, which, on the anterior side, at the junction with the hinge-line, spreads out in a subalate extension, and likewise in a less degree at the postero-cardinal extremity.

SURFACE finely granulose.

Fig. 4 *a*. The right valve. Fig. 4 *b*. The left valve. Fig. 4 *c*. Profile view.
These figures are enlarged to four diameters.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Herkimer county.

Beyrichia trisulcata (n. s.).

PLATE LXXIX B. FIG. 5 *a*, *b*.

CARAPACE minute, semioval; anterior extremity scarcely narrower than the posterior; marked by three transverse furrows which are abruptly impressed, the central one being essentially central to the entire valve, shorter and broader than either of the others, and very slightly bending at its base towards the posterior end. Anterior and posterior furrows rectangular to the hinge-line, and reaching nearly to the ventral margin; the anterior one reaching more nearly to the ventral margin, and curving slightly backwards at its base. The posterior median lobe narrower than the anterior median one, and a little more elevated; the anterior lobe narrower than either of the others, declining towards the antero-cardinal margin, which is flattened.

SURFACE very finely granulose.

This species is distinguished from any other in this group, by its minute size, and by the three transverse furrows, the central one of which is conspicuously shorter. In some of the specimens there appears to be a slight variation from the proportions of the parts as described, but I have thus far observed no essential differences.

Fig. 5 *a*. A specimen : diameter eight times enlarged.
Fig. 5 *b*. Profile view of the same.

Geological position and locality. In the tentaculite limestone of the Lower Helderberg group : Herkimer county.

GENUS EURYPTERUS.

Eurypterus : DEKAY, Annals of the Lyceum of Natural History of New-York.

Eurypterus : HARLAN, HIBBERT, FISCHER, CONRAD, VANUXEM, BURMEISTER, RŒMER, EICHWALD, PICTET, M'COY, SALTER, HUXLEY and others.

Eidothea : SCOULER.

Lepidoderma : REUSS.

HISTORICAL NOTICE.

IN 1825, the Genus EURYPTERUS was described by Dr. J. E. DEKAY in the first volume of the Annals of the Lyceum of Natural History of New-York, page 375; and a pretty good figure of the *Eurypterus remipes*, the only species then known, is given on Plate XIX of the same volume*.

In 1831, Dr. SCOULER described some fragments of a fossil crustacean, under the name of *Eidothea*, which were subsequently identified by Dr. HIBBERT as *Eurypterus* (Edinburgh Journal of Natural and Geographical Science, Vol. iii, p. 352).

1832 : LEONHARD & BRONN'S Jahrbuch.

In 1835, Dr. HARLAN, in his Medical and Physical Researches, and also in the Transactions of the Geological Society of Pennsylvania, Vol. i, p. 96 – 98, republished the generic description of Dr. DEKAY, with the description of *E. remipes;* and described and figured a second species, *E. lacustris*, copying also the original figure of Dr. DEKAY on Plate V of the same volume.

H. G. BRONN (Lethea Geognostica, 1835, pa. 109, t. 9, f. 1 & 2), figures the *E. remipes* and *E. scouleri*.

In 1836, Dr. HIBBERT published, in the Transactions of the Royal Society of Edinburgh, Vol. xiii, pl. 12, an account of a very large species of this genus, giving figures of the same, and also reduced figures of the two American species from Dr. HARLAN'S paper. This crustacean had been

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* The fossil had been previously described by Dr. S. L. MITCHELL in the American Monthly Magazine, Vol. iii, p. 291; and, from its obscure condition, was regarded as a fossil fish of the Genus SILURUS.

previously described by Dr. SCOULER in the Edinburgh Journal of Natural Sciences for 1831, as *Eidothea**.

In 1839, FISCHER DE WALDHEIM described a species of *Eurypterus* from Podolia, the *E. tetragonophthalmus* (Bulletin de la Soc. Imper. des Natur. de Moscou).

In 1841, Mr. CONRAD, in the Annual Report on the Palæontology of New-York, page 38, refers to the *Eurypterus*, recognizing but a single American species, the *E. remipes*, which, he says, when perfect, has a long spiniform tail like *Limulus*, but more obtuse and finely serrated.

In 1843, Mr. VANUXEM, in his Geological Report of the Third District of New-York, figured an outline of the head and first articulation of the *E. remipes;* such fragments being far more common than other portions of the fossil.

BURMEISTER (Organization der Trilobiten, etc., 1843, p. 62), and the same work, edited by Professors BELL and E. FORBES, and published by the Ray Society, 1846, pp. 52 & 54, and in the preceding pages, has discussed the relations of the *Eurypterus* to the trilobites and other Crustacea.

1850 – 1856 : H. G. BRONN and F. RŒMER (Lethea, pl. ix, f. 1 & 2 as above, and Pl. ix[3]), the latter figure being of the *E. lacustris* of HARLAN.

In 1851, Dr. FERDINAND RŒMER, in Dunker and Von Meyer's Palæontographica, gave a notice of the genus : "Ueber ein bisher nicht beschreibenes exemplar von *Eurypterus*, aus Devonischen schichten des Staats New-York in Nord-Amerika". The specimen figured is the *E. lacustris* of HARLAN, which preserves the head and body entire, with a portion of the spineform tail and two of the appendages on one side.

1853 : JAMES D. DANA, Crustacea of the United States Exploring Expedition under Captain C. WILKES, Vol. ii, p. 1450†.

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* Dr. HIBBERT (loc. cit.) has erroneously referred to Dr. HARLAN as the author of the Genus *Eurypterus*, citing the generic description which is quoted from Dr. DEKAY's original paper in the Annals of the New-York Lyceum.

† Dr. HARLAN is here erroneously cited as the author of the Genus *Eurypterus*.

In 1854, EICHWALD (Bulletin de la Soc. Imp. des Naturalistes de Moscou, No. 1, pa. 100, pl. 1), published a series of illustrations of the *E. tetragonophthalmus* of FISCHER, from the Island of Œsel, erroneously referring it to the *E. remipes* of DEKAY.

PICTET (Traité de Palæontologie, 1854), has copied the figure of Dr. RŒMER, referring it erroneously to *E. remipes* of DEKAY.

In 1855, M'COY (British Palæozoic Fossils of the Cambridge Museum, pa. 175, pl. 1 E, f. 1), described and figured the carapace of a species of *Eurypterus* under the name *E. cephalaspis*, the *Homalonotus cephalaspis* of SALTER.

The *Lepidoderma imhofi* (REUSS, Denkschriften Akad. Wiss. Wien, Vol. x, pa. 81, pl. 3, 1855), is undoubtedly a species of *Eurypterus*, approaching in character to *E. lacustris*.

In 1856, Notice of the occurrence of *Eurypterus* in the rocks of Lesmahago, by Sir R. I. MURCHISON (Quarterly Journal of the Geological Society, Vol. xii, pp. 23 & 24) : *Lesmahago silurianus*, MURCHISON.

Mr. SALTER, in his paper on some new Crustacea from the uppermost Silurian rocks (Quarterly Journal of the Geological Society, 1856, Vol. xii, pp. 26 & 27), refers to the Genus *Eurypterus*. The figures 4 and 5 on page 28, referred to *Himantopteris acuminatus* and *H. lanceolatus*, bear all the characteristics of similar parts of the body of *Eurypterus*. See also a note following this paper, on the structure and affinities of *Himantopterus*, by T. H. HUXLEY.

In 1858–59, Mr. SALTER (Quarterly Journal of the Geological Society, Vol. xv, Part 2, pa. 229, pl. 10), gives a notice of the genus and the previously described species, and adds six new species to the list before known*.

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* See Summary at the end of Descriptions. Mr. SALTER has fallen into an error in referring the *E. remipes* and *E. lacustris* to the same locality, viz. Williamsville, Erie county, N.Y. (loc. cit. pp. 230 & 235). The *E. remipes* occurs in Central New-York, near the village of Waterville in the town of Westmoreland, Oneida county, and in the neighborhood of that place. The *E. lacustris* occurs in the same geological horizon near Williamsville and other localities east of Buffalo in Erie county, New-York.

GEOLOGICAL POSITION AND GEOGRAPHICAL DISTRIBUTION OF THE AMERICAN SPECIES OF EURYPTERUS.

THE true geological position of the rocks containing EURYPTERUS in this country is well determined in the series; and in order to present its relations the more clearly, I give below the names of several groups in their order, that the sequence may be seen without referring to any other table of formations.

HAMILTON GROUP.	DEVONIAN.
UPPER HELDERBERG LIMESTONES, including SCHOHARIE GRIT.	
CAUDAGALLI GRIT.	
ORISKANY SANDSTONE.	
UPPER PENTAMERUS LIMESTONE.	These constitute the limestones of the LOWER HELDERBERG GROUP.
ENCRINAL LIMESTONE.	
SHALY LIMESTONE.	
LOWER PENTAMERUS LIMESTONE.	
STROMATOPORA LIMESTONE.	
TENTACULITE LIMESTONE.	A single small carapace of a *Eurypterus* is known from the Tentaculite limestone.
WATERLIME GROUP	Position of *E. remipes*, *E. lacustris* and others, with *Pterygotus* and *Ceratiocaris*.
ONONDAGA-SALT GROUP.	
NIAGARA GROUP.	

This series is found full and unbroken in the central part of the State of New-York, as in Oneida county, where the Eurypterus beds containing *E. remipes*, etc. are easily traceable passing beneath the Tentaculite limestone; while in Western New-York, and in the locality where *E. lacustris* occurs, the strata of the Lower Helderberg group are absent, and the beds bearing these fossils, together with *Pterygotus* and *Ceratiocaris*, pass directly beneath the limestones of the Upper Helderberg group which contain the remains of fishes. In the absence, therefore, of that very important group of strata, the Lower Helderberg limestones, the *Eurypterus* might seem to belong to the uppermost Silurian rocks of our country; while in fact, where the series is complete, the position of these fossils is beneath a well-marked and persistent group having intimate relations

with other Silurian strata, and containing a fauna eminently silurian in character.

The Waterlime group is in many places not clearly separable from the upper part of the Onondaga-salt group, but is entirely above the Gypsum beds. The latter group, in its lower portions, is almost entirely argillaceous or calcareo-argillaceous in composition, forming a shale or marl; but in its central and upper portions it contains alternating bands of magnesian limestone, which is variably argillaceous and siliceous; and finally the magnesian character becomes developed, and forms a group of strata from which the hydraulic cement is everywhere obtained. Hence the name "Waterlime group" has been given, from the common term applied to distinguish hydraulic cement from ordinary lime*.

The Tentaculite limestone was originally united with the rock below, under the term "Waterlime group"; but since the former rock is a thinly bedded blue or black limestone, abounding in certain organic remains, and reaching only from the Hudson river valley to the central part of the State; while the other rock, characterized by its gray or drab-colored surface and darker interior color, and almost destitute of fossils, extends throughout the State and lies below the first, it was thought proper to separate the two formations. The *Eurypterus*, though known at present but at a few points, has thus far, with a single exception, been found only in the lower strata. Several years since, I received from my friend LEDYARD LINCKLAEN, esquire, of Cazenovia, a specimen of grayish blue limestone, containing the carapace of a small *Eurypterus*, together with the little *Spirifer plicatus* so common in the Tentaculite limestone. The species is quite distinct, in the form of the part preserved, from any other known to me. The specimen is from the central part of the State, and about as far west as the known extension of the Tentaculite limestone.

* At the time Dr. DEKAY described the *Eurypterus*, very little was known of the sequence of our formations, and even the lithological characters were not always clearly defined, and of this rock he wrote as follows: "It is said to be clay slate by Dr. MITCHELL; graywacke slate, calciferous sandrock, transition sandrock, etc. by others." Subsequent authors have several times cited this fossil as from the Slate or Graywacke formation, while in truth it is in the midst of the most extensive Calcareous formation of the Palæozoic strata in the Eastern United States.

Although found in a loose fragment of limestone, the character of the rock and the associated fossils are conclusive in regard to its geological position.

These peculiar organisms, found thus between the Onondaga-salt group below and the Lower Helderberg group above, I have referred rather to the former; for while the occurrence of the single carapace of a species of *Eurypterus*, associated with known fossils of the Tentaculite limestone, allies the formation in some measure with the rocks above, its lithological associations are altogether with the rocks below.

The sequence of strata above given shows conclusively that the Eurypterus beds are not to be regarded as of Devonian age. The rocks of the Lower Helderberg are admitted to be Silurian; and while no one would include in the Devonian period rocks below the Oriskany sandstone, this, from its mingling of species, may be regarded as debatable ground. The *Eurypterus* (with a single exception) lies therefore between the Niagara and Lower Helderberg groups, in strata above those containing the fossils represented in the second volume of the Palæontology of New-York, and below those containing the fossils represented on the first seventy-nine plates of the present volume*.

It seems scarcely necessary, therefore, to discuss the question of the age of the strata containing the *Eurypterus;* and I introduce these remarks to correct the erroneous reference frequently made of these fossils to the Devonian system.

In comparing the rocks of this country with those of Europe, we learn from the investigations of Sir RODERICK MURCHISON that he has always found the strata characterized by these crustaceans immediately to underlie the rocks of undoubted Devonian age. This eminent geologist remarks:

* The *Eurypterus* should indeed more properly have formed the concluding part of the second volume of the Palæontology of New-York; but at that time the collections possessed by me, or known to exist in the State, were too meagre to afford means for a proper illustration of the species, and much less for adding to our knowledge of the structure of the animal. The descriptions were accordingly postponed to the third volume, and are placed at the end of the Crustacea, not as indicating their geological relations, but as a distinct group to be studied by themselves; while their geological place, in reference to the fossils of this volume, would precede those of the first plates.

"Wherever these large crustaceans are found, and with them small Lin-
"gulæ and other fossils, we may be sure that we are at or near the very
"summit of all rocks to which the term *Silurian* can be applied, and that
"the next overlying stratum belongs to the first great era of fishes, the
"Devonian, or Old Red standstone; for the thin transition band now
"under consideration still remains what I stated it to be twenty-one
"years ago, the lowest in which the trace of true vertebrated animals
"has been detected" *.

Sir RODERICK has shown that a similar group of crustaceans occupy a parallel position in the uppermost Silurian beds near Lesmahago in Scotland*; and from facts elsewhere observed, infers that gigantic crustaceans of the same genera mark the uppermost Silurian zone everywhere in the northern hemisphere. He further says: "Near Ludlow, Hereford and "several other places, the thin course with small fish-bones has been "traced over an extensive area; and in several places where the fishes "are wanting, the band is still characterized by the associated large "crustaceans"†.

In this country, however, the line of demarcation between the strata containing these crustaceans, and those containing the fishes, is very clearly marked, even where the two sets of strata are in contact; the lower or crustacean beds being always an argillaceous magnesian limestone, while the higher beds, or lowest fish-bearing beds, are of gray or bluish gray limestone, which, however, in some localities, becomes of a drab color, but never loses its distinctive features, or assumes the character of the rock below.

In New-York, and so far as we know in the United States, the first appearance of these peculiar crustaceans is at the epoch of the Clinton group, where some fragments of spines, apparently of *Ceratiocaris*, are known to occur. Well-marked spines of *Ceratiocaris* (one of which is six inches long, the *C. deweyi*) have been found in the Niagara group, and species of this genus occur with *Eurypterus* in the Waterlime group; while from strata above this horizon, no remains of similar character have

* Quarterly Geological Journal, Vol. xii. p 24. † Id. p. 23.

yet come to my knowledge. In England remains of *Ceratiocaris* occur as low as the Wenlock limestone, which may be regarded as the equivalent of the Niagara group.

Notwithstanding the numerous localities and the great extension of the Niagara and Onondaga-salt groups through the States west of New-York to the Mississippi river, I have not yet seen a single representative of these peculiar crustaceans from any of these localities. Still the limestone with fish-remains in some parts of the west, as in Ohio, Michigan and Indiana, is far more prolific in these vertebrata than in any of the eastern localities. The same remark is essentially true of the southwestern extension of these strata. Although I have examined large collections of fossils from the Niagara and Lower Helderberg groups from as far southwest as Tennessee, I have yet failed to discover any remains that could be identified with either of the crustacean genera *Eurypterus*, *Pterygotus* or *Ceratiocaris*. At the same time smaller collections from the upper limestones, or those of the age of the Upper Helderberg, have shown some remarkably fine specimens of the teeth of fishes.

In Wisconsin we find strata of the same age as those containing the *Eurypterus* of New-York, and these are immediately succeeded by beds of the age of the fish-bearing strata of New-York. The same is true of Illinois, and of some parts of Iowa; but in the latter State, I have not yet identified any fish-remains in the higher strata*.

In the collections of the Canadian Geological Survey, I have observed some fragments bearing the peculiar surface-markings of *Eurypterus* and *Pterygotus*. These specimens are from Gaspe; and from their association with known fossils of the age of the Lower Helderberg group, I have presumed them to lie at the base of that formation, and they may perhaps be upon a horizon varying little from that of the Waterlime group of New-York.

We shall observe, therefore, that the zone of strata marking the com-

* In 1855 I collected, among other things from the strata corresponding to the upper beds of the Onondaga salt group at Leclaire in Iowa, a small slab covered with what appeared to be the scales of fishes. This specimen was sent with the others to Iowa city, and I have not since seen it. This is the only evidence of the occurrence of fishes west of the Mississippi river which I know.

mencement of vertebrate life is well and widely marked in the United States, showing the simultaneous appearance of this class of animals at numerous and distant points in the wide-spread ocean of that period. In the present state of our knowledge, we must regard the remarkable crustaceans marking the decline of the Silurian period as far less widely distributed than the fishes, which are considered as indicating the dawn of the Devonian period; and relying upon these remains as characteristic, we find that the occurrence of these crustaceans is a far less persistent guide for determining the close of the Silurian period, than the presence of fishes for indicating the commencement of the Devonian.

The generalizations offered by Sir RODERICK MURCHISON are of great interest and importance, and (though in the United States the Oriskany sandstone may still be debatable ground) the views he has expressed regarding the silurian age of these fossils are strongly sustained by all that we yet know concerning the relations of the strata in which they occur. These suggestions, joined with our knowledge of the age of the strata containing *Eurypterus* and the associated crustaceans in New-York, are interesting and important, both in regard to the horizon which we are to rely upon as the recognized one between Silurian and Devonian strata in Europe, and as indicating the zone in which we are to look for these peculiar organisms.

Throughout the many hundreds of miles of the outcrop of these formations there is no mingling of the materials of the two epochs, and consequently no opportunity for the continuance of the fauna of the lower beds into the higher ones. We may except perhaps the Oriskany sandstone, where we detect a commingling of characteristic types of both lower and higher rocks; but even here the line is widely distant from the horizon of the peculiar crustaceans. With this strong physical demarcation, and the stronger, if possible, palæozoic distinction, we are scarcely prepared to conceive of these remarkable forms occurring in the beds of passage to the Old Red sandstone, and in the Devonian itself, as indicated by Mr. SALTER in reference to *Eurypterus acuminatus*, *E. megalops* and *E. symondsi*. The evidences presented to this eminent palæontologist have induced him

to assign a greater geological range to the *Eurypterus;* and he remarks: "The range of the genus, therefore, so far as yet known, certainly is "confined between the Ludlow rocks and the base of the Carboniferous "system. Apparently it did not commence to exist so soon as its gigantic "ally, the *Pterygotus;* but it continued to live on longer, and attained "its maximum of size in beds higher than those in which *Pterygotus* is "known to have been found"*.

Thus far our experience in the United States leads us to coincide more nearly with the opinion of Sir R. I. MURCHISON, who regards these peculiar forms as having very limited geological range. It appears to us that the Old Red sandstone localities cited should be reviewed with the greatest care; and although there could seem to be no doubt but the *E. scouleri* occurs in Lower Carboniferous strata or in Upper Old Red, our science would be greatly benefited by a thorough review and revision of the whole subject, aided by the light lately acquired in regard to these very interesting organisms.

The few fossils that have been found associated with *Eurypterus* are: A small species of *Leperditia*, and more rarely a larger one; a single specimen of *Discina*, and one of *Conularia;* and a small species of *Lingula* is not uncommon in the same beds in Western New-York. Associated with *E. lacustris* near Buffalo, Mr. COBB has obtained a fragment of *Pterygotus;* a genus for the first time, so far as I know, recognized among our American fossils.

I have, also, among the collections accompanying the *E. remipes* from Waterville, a fragment showing several articulations with post-oral plate and portions of the anterior feet on one side, which differs so far from *Eurypterus* as to induce a doubt as to its generic identity with that fossil, and which is probably a *Pterygotus* or a closely allied form. In the same collection there are fragments of a *Ceratiocaris;* and the collections of Mr. COBB from Williamsville have shown several fragments, with some nearly entire but distorted specimens of the same. Besides these, a few other organisms are associated with the *Eurypterus*, the relations of which have not yet been determined.

* SALTER on *Eurypterus*: Quarterly Journal of the London Geological Society, Vol. xii, p. 235.

AFFINITIES OF THE GENUS EURYPTERUS.

Dr. Dekay, in his original observations on *Eurypterus*, referred the fossil to the Branchipodal Crustacea (Entomostraca), and has indicated the Genera Apus, Binoculus and Lepidurus as the forms to which it seems most nearly allied; and later writers have expressed similar views of the relations of this fossil*.

Burmeister (op. cit.) has shown the analogies of the Trilobites with the Phyllopoda, in three of the principal genera, Apus, Branchipus and Limnadia; and he suggests that the *Eurypterus* was a shelless trilobite, as *Branchipus* is a shelless phyllopod. The Eurypterideæ are arranged by him as a family with Cytherinideæ and Trilobitæ, under Palæadæ.

Dr. F. Rœmer has suggested the affinity of *Eurypterus* with *Limulus*; indicating, however, the great difference in the feet, etc. Prof. M'Coy† has adopted the same opinion, and has united the *Eurypterus* and *Pterygotus* in the Family Eurypterideæ (Burmeister).

Mr. Huxley‡, in his observations on the structure and affinities of *Himantopterus* (= *Pterygotus*), remarks that "Analogies, if not for *Himanto-*

* Dr. Harlan has adopted the descriptions and references of Dr. Dekay without comment, as to the relations of the fossil among the Crustacea; while Dr. Hibbert* has cited Dr. Harlan as follows: "The *Eurypterus* is assigned by Dr. Harlan to the Class Crustacea and to the Order "Branchipoda. His description is as follows". Here is given the original description of Dr. Dekay, and then he says: "Dr. Harlan's specimens were obtained from a transition calciferous sandrock "of Westmoreland in the Oneida county of New-York. He has described two fossil species, the "*Eurypterus lacustris* and the *E. remipes* (See Plate xii, figs. 6 & 7)".

I cite this, to correct both the error in giving Dr. Harlan as the original authority for these two species, and also the erroneous reference to localities, as will be seen by consulting the paper of Dr. Harlan.

Mr. Salter says (Quarterly Journal of the Geological Society, Vol. xv, p. 230): "Dr. Harlan, ".too, in his Medical Researches [Medical and Physical Researches], had given similar but rather "more perfect figures of two species from Williamsville, Buffalo, in the State of New-York". The truth is, Dr. Harlan has given a figure of Dr. Dekay's species *E. remipes* copied from the original figure in the Annals of the New-York Lyceum, as expressly stated by him, for the purpose of comparison with the proposed species *E. lacustris*, which is less perfect than the figure of *E. remipes*.

† British Palæozoic Fossils, page 175.

‡ Quarterly Journal of the London Geological Society, Vol. xii, p. 35.

* Transactions of the Royal Society of Edinburgh, Vol. xiii, p. 281.

" *pterus*, at least for the very closely allied genus *Eurypterus*, have been " sought by different naturalists among the Pœcilopoda, the Phyllopoda " (particularly *Apus*), and the Copepoda; and MILNE-EDWARDS has sug- " gested that *Eurypterus* possibly holds an intermediate position between " the Copepoda and the Isopoda".

I am not prepared to agree with Mr. HUXLEY in the opinion (expressed in the succeeding page of the paper cited) that this form and *Pterygotus* (*Himantopterus*) are related to *Cuma* and *Mysis*; though in every step of the comparison, the larval expression of the fossil, so to speak, is constantly forced upon our notice.

Mr. DANA, from an examination of some of the drawings of my specimens, suggested an analogy with *Sapphirina*; and this analogy with the allied genus *Pterygotus* is certainly in many respects very conspicuous, particularly in the form of the animal, and in the situation of the cornea lenses on the margin of the carapace.

As my examinations have progressed, and the parts now shown have gradually been brought out in their true relations by the study of a large number of specimens, many structural analogies with *Limulus* have been observed. At the same time, both in the form of the feet and in the jointed body, the great dissimilarity with *Limulus* is apparent; but I am not prepared to maintain that these external differences are of ordinal importance*.

The original description of Dr. DEKAY recognized four pairs of feet, the third pair of which were longer than the two anterior pairs and the fourth pair, which are placed near the junction of the head with the abdomen; being, as he says, larger in proportion to the body than in any living genus of Crustacea with which we are acquainted.

The description and figure of Dr. HARLAN has added nothing to our knowledge of these organs, and I have not seen any illustrations which better serve to represent them. Mr. SALTER remarks that "All these re- " presentations showed that the *Eurypterus* possessed at least three pairs

* Mr. MORRIS, in his invaluable work, "A Catalogue of BRITISH FOSSILS," has arranged the Eurypteridæ, including *Eurypterus* and *Pterygotus*, as a family following Limulidæ, under the same order.

" of appendages, of which the hinder were dilated for swimming"; and the illustrations by M. EICHWALD of the Russian species, and the observations of Professor M'COY, show that the number and character of these appendages were similarly regarded by them all*.

Fortunately I am able, in three distinct species, to show that the *Eurypterus* was possessed of five pairs of appendages or organs of sense and motion; the four posterior pairs being those seen by Dr. DEKAY, while the anterior pair, being a little shorter, though similar to the two next, are rarely seen. This number being established for three species, we may presume that it is a feature of generic importance, and that the descriptions which recognize the existence of three pairs only have arisen from imperfect specimens.

The articulation of these appendages has never been clearly shown in any of the figures which have fallen under my observation; the original figure of Dr. DEKAY being indeed better than any subsequent one, though that by Dr. HARLAN gives a better knowledge of the fourth pair (third of DEKAY), the number of articulations being correctly represented. The figure of Dr. RŒMER, though of a very large and beautiful specimen, has failed to exhibit the true structure of these appendages.

Since the descriptions were written and the preceding pages in type, wishing to present the opinion of the highest authority in regard to the zoological affinities of these fossils, I have submitted the collection of specimens of *Eurypterus* in my possession to the examination of Professor AGASSIZ. This pre-eminent naturalist has given his opinion most unequivocally that the *Eurypteri* are closely related to *Limulus*, belonging even to the same order. He regards the antennal system as entirely absent. The organs of locomotion all belong to the cephalic region; and while externally they perform the functions of feet, they are at their bases organs of manducation. The central organ, indicated as a locomotive appendage, and attached to the lower side of the first segment, Professor AGASSIZ regards as similar to the appendage attached to the membrana-

* I regret that I have not been able to see the illustrations of Professor EICHWALD, referred to above.

ceous feet behind the swimming feet of *Limulus;* and, instead of being double, is anchylosed as in young *Limulus*.

Since my comparisons, during investigations of these fossils, had been made almost entirely with *Limulus*, I am prepared to appreciate these views of Professor AGASSIZ*.

The following is the description of the genus by Dr. DEKAY :

"CAPUT a thorace non distinctum. Os ignotum. Oculi duo, sessiles, distantes, lunati. Abdomen elongatum, posticam versus extremitatem sensim gracilius, segmentis transversis subimbricatis divisum. Pedes octo; duo utrinque antici branchiferi, duo utrinque postici maximi, omnes lamellosi."

The specimens examined enable me to extend this description, and the genus may be characterized as follows :

GENUS EURYPTERUS (DEKAY).

BODY ovato-lanceolate, broader in front, gradually attenuated behind, and terminated in a spiniform tail. Carapace on the upper side entire, somewhat semioval, wider than long. Eyes two, reniform or oval, distant, sessile, placed within the margin of the carapace : simple oculiform tubercles, or corneæ, two, situated subcentrally on the carapace. Thoracic and caudal portions composed of thirteen joints : the first set of these, belonging to the thorax, are narrower; the others, constituting the caudal or abdominal portion, are subquadrate, except the terminal joint, which is prolonged into a sublinear or lanceolate triangular spine with serrated edges.

The first thoracic articulation on the lower side is double, consisting of the first two joints of the back anchylosed in one, and showing the suture. A central locomotive appendage is attached to and proceeds from the upper part of the first joint; and dividing the lower half of the same, it

* This volume having been in print for a long time, with the exception of the hiatus left for the *Eurypterus*, its completion can no longer be postponed; but the descriptions with the illustrations will appear as a separate paper, for which Prof. AGASSIZ has promised me a preliminary or introductory note.

extends to the third or fourth : this appendage is jointed towards its extremity, and terminated by two slender, flexible? processes, and has apparently been capable of considerable freedom of motion. The remaining joints of the lower side of the body present no conspicuous differences from those of the upper side.

The mouth is placed centrally beneath the carapace, and surrounded by four pairs of small jointed feet, and a fifth larger pair. The three anterior pairs are similar to each other; and several of the joints are furnished at their distal extremities, on one or both sides, with a small articulating spine, and the terminal joint consists of a long spine. The fourth pair of feet are more slender, and the joints longer. The fifth pair of feet are natatory, longer and more dilated than the others, and placed beneath the posterior margin of the carapace. The basal joints of these, consisting of broad rhomboidal plates, are serrated on their inner anterior approximate margins, and thus fitted for performing the functions of jaws: together they cover nearly the entire width of the lower part of the carapace, and extend a little below the line of its posterior margin. Lying over the inner edges of these plates is a longitudinally oval, ovate, or cordiform central post-oral plate, at the anterior sinuate margin of which is very clearly the entrance into the mouth : towards this, the bases of the five pairs of organs are all converged*.

The surface of the head and parts of the body is often finely granulose; and that of the articulations, the bases of the joints, and sometimes other portions, are marked by an imbricating scale-like sculpture. These scale-like facets are of varying size and elevation, and rarely closely arranged. There are sometimes four or six rows of more prominent pustulose scales arranged along the centre of the back to the base of the thoracic articulations, while two similar rows mark the last six joints.

The texture appears to have been elastic or leathery, and the substance very thin.

---

* If chelate appendages similar to those of *Pterygotus* have ever existed in *Eurypterus*, they must have been very small, and situated in advance of the first designated pair of feet, and may have resembled those of *Limulus*. In two instances I have seen some indication of a small appendage in this position, but a farther examination does not offer any confirmation of this view.

The different species of this genus present some slight modifications in general form and in the appendages. The feet are all surrounding the mouth, and belong to the cephalic portion of the animal. The anterior feet are nine-jointed, including the terminal articulating spine : the first joint is narrow at its base and spreading above, and the second joint is longer than the others. In the three anterior pairs, the distal extremities of several of the articulations preceding the last one have a slender spine on each side ; but this character may perhaps be varied by original conformation, or by accident. The dilated portion of the first joint is intended to aid in the process of manducation, and may have been serrate.

The accompanying diagram is an enlarged figure of one of the third pairs of feet.

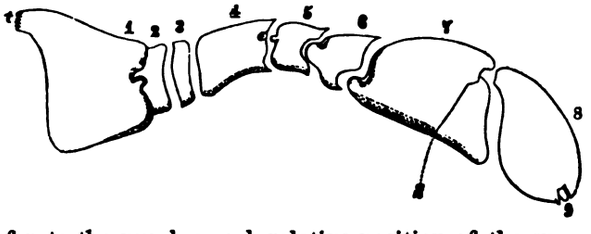
Fig. 1.

In the arrangement of these appendages, the part *a* of the second joint is covered by the next one behind it as far as the oblique line limiting what appears to be a flattened portion of the joint. A part of the first joint *b* was, in like manner, covered by the next posterior one.

The fourth pair, which are more slender than the others, with longer joints, have shown no spines except on the penultimate, and the last joint is itself a slender spine.

The fifth or swimming feet are eight-jointed, with a terminal palette*.

Fig. 2.



The figures refer to the number and relative position of the successive joints of the natatory feet.

At *t* the margin is serrated, as mentioned in the description above.

At the line *s* there is a soldered suture, connecting the fixed ramus of the chela with the penultimate joint. In some specimens the parts have been separated along this line.

* In indicating the number of joints, I have been governed by no theoretical views, but simply by the appearances of separation in the parts; and though the two extremities of the third joint, as marked, show no articulating processes, the limitation of the parts is distinct, and they may have been separated only by a thin extension of the chitine, and may not be properly articulating surfaces.

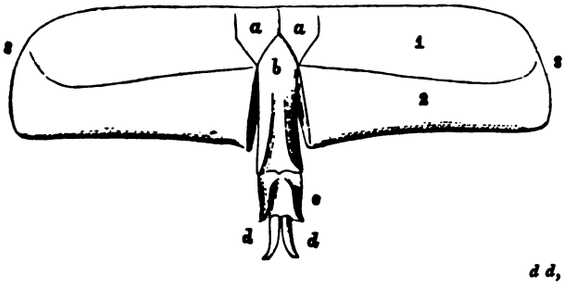
The first joints of this last pair of feet are broad subrhomboidal plates, already noticed as covering the posterior half of the carapace, the adjacent edges of which are serrate for the purposes of manducation. The second joint is short and stout, and articulated to the first one by a strong process. The third joint is very short. The fourth joint is usually equal to, or longer than the two first. The fifth and sixth joints are smaller. The seventh joint is suddenly dilated, wider and longer than the preceding, rhomboidal, having the penultimate joint articulated close to its distal anterior margin; while along two-thirds of its width there is a triangular piece attached by a soldered suture*, the sloping edge of which forms one side of the pincer-like chela. The eighth joint is subovate, rarely narrower at its upper extremity, and articulated nearer to its anterior edge; so that in its motions, it had the inner cutting edge placed against the sloping side of the triangular process of the preceding joint : thus the inner adjacent edges of these parts were fitted to move over each other as the blades of a shears, one being relatively fixed and the other free. The extremity of the last joint is bilobed at the tip for the articulation of a terminal palette, as shown in the figure.

In the articulation of the joints of these appendages, there is much more freedom at the base of the seventh joint, which, with the succeeding one, forms a prehensile chelate extremity of peculiar character.

The post-oral plate appears to be attached simply by the muscles to the parts below.

The first or double segment of the body on the lower side, with its appendages, sometimes occurs separated from other portions of the body; as in the accompanying figure, which is copied from one of these separated joints.

Fig. 3.



The anchylosed first and second segments of the body, 1 & 2. The suture *ss* marks the line which, on the back, is the articulating line of the two segments.

The parts *a a* are two intercalated pieces joined by sutures to the other parts, the outer suture lines not reaching to the upper edge of the segment.

b, the first joint of the locomotive appendage.

c, the second joint of the same.

d d, the extreme free appendages of this organ.

In the centre of the upper division of this joint are inserted two pieces, leaving a triangular space or emargination behind, into which the locomotive appendage is inserted and joined by sutures : although dividing the lower half of the articula-

* I infer this to be a suture from the fact that there is always a visible dark line along the junction, and an apparent slight thickening of the substance left in the stone, while the parts are not unfrequently separated along this line.

tions, it appears to be free from attachment to the adjacent parts, and would apparently leave beneath it a communication with the internal economy of the animal. This appendage has an articulation below the margin of the body segment to which it is attached; and at the extremity of this joint are articulated two terminal processes, giving considerable freedom of motion to this part*.

The under part of the carapace with its organs, including some of the first segments of the body, is represented in the figure on the following page. This diagram is constructed nearly of the size of the largest specimen of *E. lacustris*. The relations of all these parts are demonstrable in several individuals.

In the process of compression, the organs surrounding the mouth are flattened, and more or less displaced in nearly all the specimens. In their natural relations, the rounded bases of the first four pairs of feet are more nearly over one another, and the mouth has a more vertical or less elongate form; while in the figure, in order to conform to the actual conditions, but more in order to show the parts clearly, they have been drawn in this manner, so that the mouth has twice the length that otherwise it would have. As the feet lie one partially above the other, the bases of the fourth pair of feet are covered by the first joint of the fifth pair, as far as the ridge shown upon the long second joint; while the bases of the third pair are, in like manner, covered by the fourth.

* This organ bears so much resemblance to the membranaceous feet of *Limulus*, that I introduce in this place a figure of the same. In GRIFFITH'S edition of CUVIER'S Animal Kingdom, Vol. xiii, page 362, in describing *Limulus*, the following language is used : "The last two feet of this "buckler are united, and in the form of a large membranaceous leaflet, almost semicircular, sup- "porting the sexual organs at its posterior face, and presenting in the middle of an emargination of "the posterior edge two small triangular divisions, elongated and pointed, which appear to represent "the internal fingers of the forceps. Some sutures indicate the other articulations."

Fig. 4.

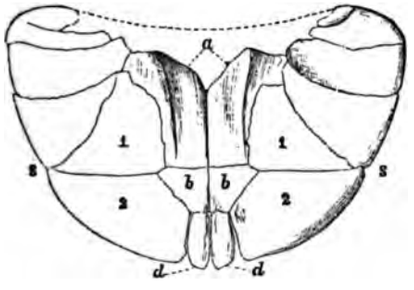


Fig. 4. The membranaceous feet referred to above. The letters correspond to those used in the figure of the locomotive appendage of *Eurypterus*, for parts supposed to have a similar relation.

The similarity of form and relative position of the appendages in *Eurypterus* is at once obvious, and we may suppose that the organ has performed similar functions.

Fig. 5 : Eurypterus lacustris.

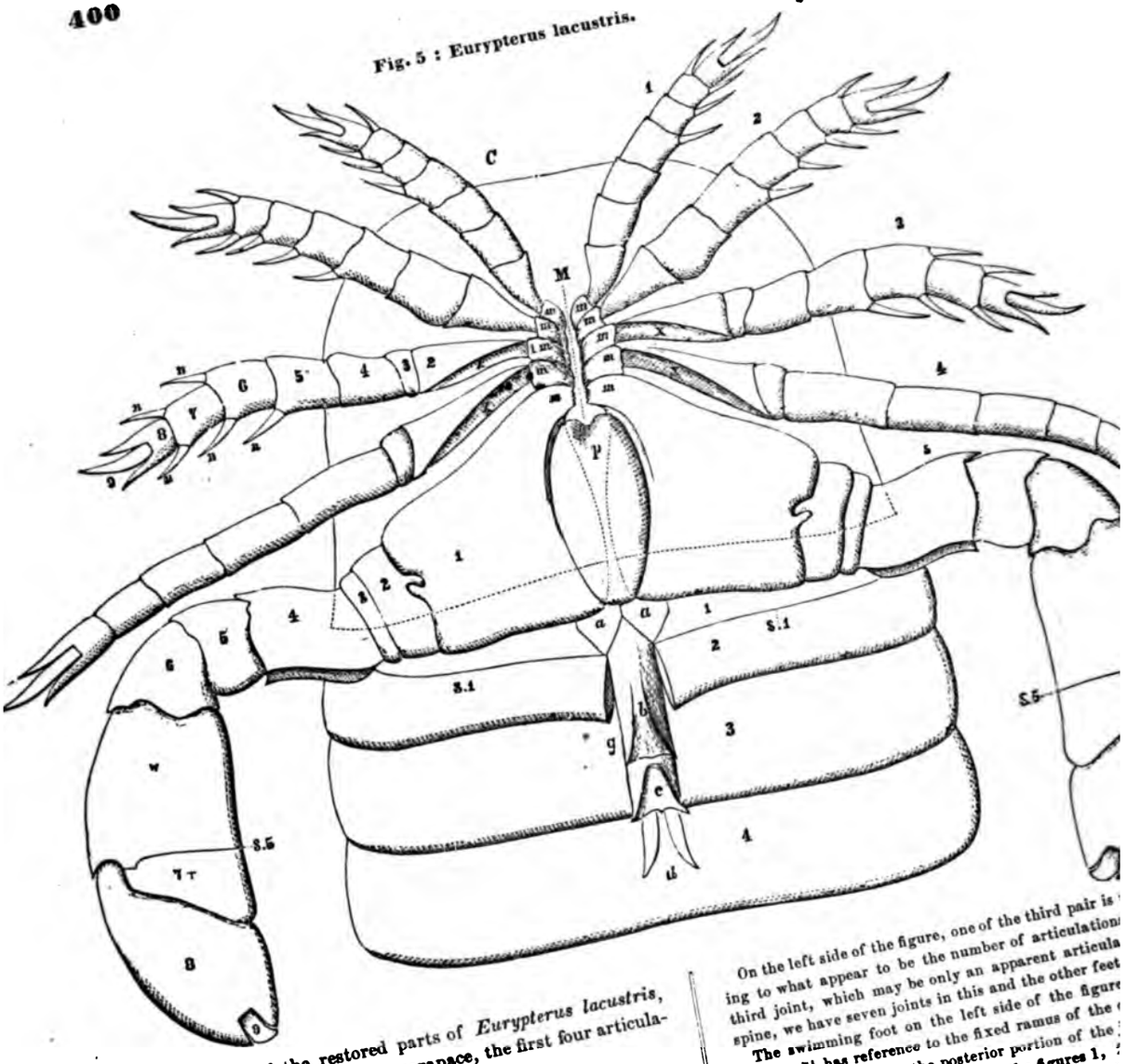


FIG. 5. A figure of the restored parts of *Eurypterus lacustris*, showing the lower surface of the carapace, the first four articulations of the body, the feet, etc.

C, the carapace; M, the mouth; P, the post-oral plate.

m, m, the bases of the first joints of the feet, all or a part of which perform the functions of jaws.

x, x, the flattened spaces which are covered by the next succeeding member when the parts are in their natural position.

The feet on the right side of the figure are numbered 1, 2, 3, 4 and 5, corresponding to the orders of the pairs of appendages.

On the left side of the figure, one of the third pair is ing to what appear to be the number of articulation third joint, which may be only an apparent articula spine, we have seven joints in this and the other feet

The swimming foot on the left side of the figure The fig. 7† has reference to the fixed ramus of the which this is joined to the posterior portion of the

In the articulations of the body, the figures 1, to the number of the segments in their order. The of the locomotive appendage have already been ex

From the preceding descriptions and illustrations, the relations of all these parts will be easily understood.

The Genus EURYPTERUS differs from PTERYGOTUS in having, according to the figure of *P. bilobus* of SALTER, one more articulation in the body; and while the caudal articulation of that species is bilobed, that of all the *Eurypteri*, so far as known, is simple, elongate and spiniform. The anterior feet of the *Eurypterus* have the joints furnished with smooth chelate tips, which are not prehensile as in *Pterygotus* : the articulation of the natatory feet in the two genera is likewise distinctive (as shown in the figure of Mr. SALTER). The eyes of *Eurypterus* are usually, or perhaps always, within the margin of the carapace, while those of *Pterygotus* are marginal. The central oculiform tubercles shown in the carapace of *Eurypterus* have not been shown in *Pterygotus*.

In the scaly covering of the body, I have not been able to discover any important differences between that of *Eurypterus* and that of other specimens which I have reason to believe are *Pterygotus*. There is likewise great apparent similarity of structure in other parts of these peculiar crustaceans.

The cordiform "scale-like appendages", one of which is figured by Mr. SALTER*, appear to me to be the epistoma, or plate covering the bases of the first joints of the posterior pair of feet, and lying just behind the mouth; and though no such organ has yet been shown as belonging to *Pterygotus*, they may have had similar relations to that fossil.

The palette in the extremities of the natatory feet of *Pterygotus* is very similar to the corresponding part of *Eurypterus*, though much more developed; and the number of joints in these organs do not correspond in the two genera.

This terminal palette has never been noticed, so far as I am aware, until the present time; and in the two previously known American species of *Eurypterus* it is extremely small, while in one species it equals the preceding joint in size.

The number of joints in the feet is much greater in *Eurypterus* than in *Pterygotus*, according to Mr. SALTER's figure. The number of joints of the body, as shown by the same figure, would correspond with those of *Eurypterus*, admitting the first one on the lower side to consist of a double articulation soldered together, and representing two joints of the dorsal side.

The bilobed character of the last articulation is a distinguishing feature, and doubtless of generic importance; and it is not probable that any species with spiniform tails will be found to be true *Pterygotus*.

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* Quarterly Journal of the Geological Society, Vol. xv, pag. 28, fig. 7.

The scale-like sculpture is rarely or never seen upon the carapace of the *Eurypterus*, and though sometimes conspicuous on the dorsal surface, is usually best preserved on the lower side of the body joints. The margins of the swimming feet in their last joints, and sometimes other parts, are faintly or strongly serrate in different species. The joints of the caudal portion in the different species vary conderably in the posterior marginal extension on each side, which is sometimes almost spiniform.

With a single exception, all the specimens of these crustaceans, showing the feet, have the joints of these organs short and numerous : in that exception, these appendages are more slender, and the joints much elongated, four or five only having been preserved, and these show no small spines at their tips. In the articulations, and in the proportions of the parts of the body, this specimen bears more resemblance to the figure of *Pterygotus* above referred to; but in other respects it has the character of *Eurypterus*, preserving the maxillary plates of the posterior pair of feet, with serrated margins, and a narrow cordiform post-oral plate, while some portions of the last pair of feet still remain. The joints of the body do not differ from those of other species of *Eurypterus*, except in having a greater proportional length.

The specimens heretofore known, both in Europe and America, have the lunate or reniform eyes placed much within the margin of the carapace; and this feature is regarded as of generic importance. In a single carapace, which has otherwise all the appearance of belonging to *Eurypterus*, the eyes are broadly oval, and placed on the margin of the carapace; but this may be a *Pterygotus*, or an allied genus.

The figures on the next page, representing a restoration of the *Eurypterus*, are given from the examination of numerous specimens; and every part here represented has been seen in its proper place and in its true relations to other parts of the animal, as will be shown hereafter in the several parts of *E. remipes* and *E. lacustris* and others.

The rows of dark spots on the back of the specimen fig. 1 indicate the scale-like elevations, of which, in very perfect specimens, we have four series on the first six segments, and two on the next six segments of the body. In the compressed specimens, and in impressions of the body in stone, these marks often appear like pores penetrating the crust; but I have not found evidence of any such feature in the more perfect specimens examined.

Fig. 6 : Eurypterus remipes.

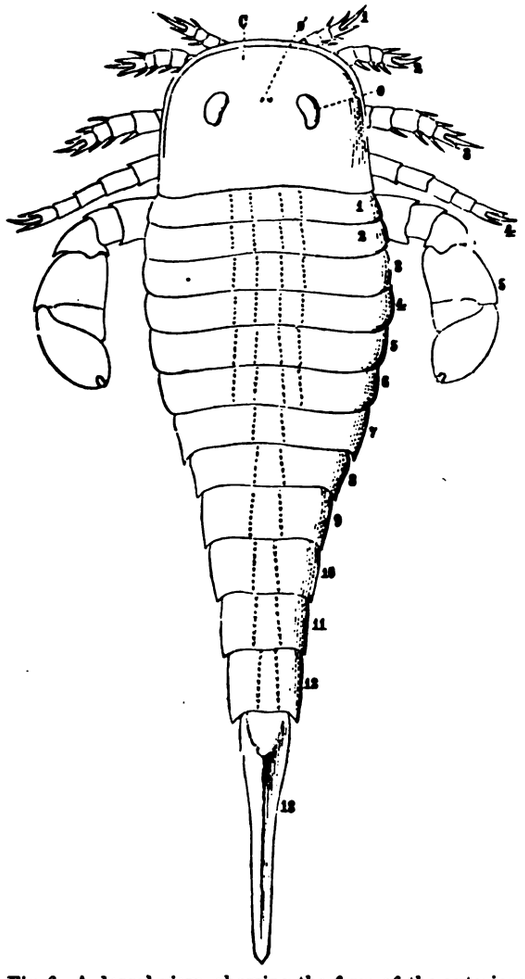

Fig. 6. A dorsal view, showing the form of the exterior; the several organs of locomotion protruding from beneath the carapace, according to their true proportions as shown in actual specimens.

C, the carapace; *o*, the eye; *o'*, the central oculiform tubercles.

The numbers near the feet refer to the order of these appendages.

The numbers on and near the articulations of the body refer merely to the order of these segments behind the carapace.

Fig. 7.

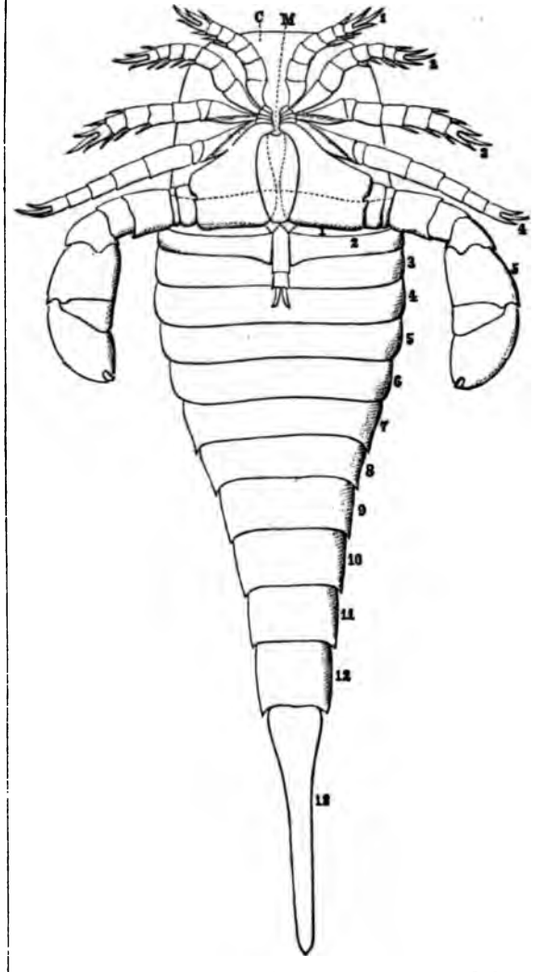

Fig. 7. The lower or ventral side as reconstructed from several specimens, showing the relations of the different parts.

C, the carapace; M, the mouth. The other figures refer to parts already explained.

It will be observed that the first joints of the fifth pair of feet cover the upper part of the first segment of the body, which is marked 1; and the line between 1 and 2 is shown less conspicuously than the others, it being, as already explained, a close suture line.

Eurypterus remipes.

PLATE LXXX. FIG. 1 – 12; PLATE LXXX A. FIG. 1 – 6; and PLATE LXXXIII B. FIG. 2.

Eurypterus remipes : DEKAY, Annals of the Lyceum of Natural History of New-York, Vol. i, pa. 375, pl. xxix : 1825.

E. remipes : HARLAN, Transactions of the Geological Society of Pennsylvania, Vol. i, pa. 96, pl. v : 1832.

— — : Idem, Medical and Physical Researches.

— — : MILNE-EDWARDS, Hist. Nat. des Crustacées, III, p. 422.

— — : BURMEISTER, Organization der Trilobiten, p. 62 : 1843.

— — : Idem, Ray Society Publication, 1846, p. 54.

— — : BRONN, Lethea Geognostica, I, p. 109, t. ix, f. 1.

— — : SALTER, Quarterly Journal of the Geological Society of London, p. 235 : 1859.

Also cited by numerous other authors.

Not *Eurypterus remipes*, EICHWALD, Bul. Imp. Soc. Nat. Moscou, 1851.

Not — — RŒMER, Palæontographica, I, t. 27 : 1848.

Not — — RŒMER, Lethea, Ed. III, 1854, t. ix^3, f. 1.

CARAPACE roundish or semioval, about three-fourths as long as wide, often "marked anteriorly by a deep indented line formed by the junction "of the superior and inferior plates". Eyes lunate, depressed or moderately convex, marked by concentric striæ. Body moderately convex above, elongate, tapering; the thorax in the middle a little wider than the carapace, contracting below the seventh articulation; the abdominal portion distinctly narrower, and the length of the joints increasing, the last being extended into a long slightly curved triangular spine which is serrated at the angles. Joints of the body slightly imbricating; and some of the abdominal joints, at the lateral margins, slightly prolonged over the ones below in angular processes.

On the lower side, a small oval post-oral plate, slightly notched on its anterior margin, overlaps the adjacent edges of the broad plates of the swimming feet, and apparently lies upon the cavity of the mouth. The four anterior pairs of feet converge towards the anterior margin of this plate : the first joints are short, and the second ones much longer; the first two or three joints are unarmed, while the remaining ones are furnished on their outer angles with smooth chelate tips, the extreme one of all being the longest. The two anterior pairs of feet extend b

Fig. 7. The abdominal articulations, and the posterior spine, separated from the thoracic rings.

Fig. 8. An imperfect caudal spine, with the last two articulations of the abdomen.

Fig. 9. The caudal spine : a lateral view of a specimen not quite entire. The lefthand is the dorsal side, and the general form is triangular, becoming more convex on each side of the dorsal edge towards the base.

Fig. 10. The ventral side of a fragment, showing, on the lefthand side of the figure, at *a*, the articulation of one of the swimming feet, with the large maxillary joint, which is nearly in its natural position, while the opposite one is displaced. The basal articulations of the anterior feet are likewise seen more distinctly than in any other specimen : the first and second are broken off, while the third is nearly entire, and preserves the minute spines on the lower side of each joint.

Fig. 11. A fragment showing the inner side of several of the thoracic articulations, and preserving the anterior feet nearly entire, with the articulations of one of the swimming feet ; the place of attachment of these is obscured by some of the plates of the body below.

Fig. 12. The post-oral plate of this species.

PLATE LXXX A.

Fig. 1. The ventral side of an imperfect specimen preserving the thoracic segments and four of the abdominal joints, with the impression of one of the swimming feet entire, and the other with the penultimate joint separated. Impressions of the maxillary plates remain, showing their original form, as also the form of the post-oral plate. The bases of the four anterior pairs of feet still remain, showing the place of their origin.

The last joint of the foot appears in this individual to slide over the triangular piece of the preceding joint upon the lower side, which is not true : this appearance arises from the fact that it is a mould of the upper or dorsal surface of this organ.

Fig. 2. A part of the head of this species, showing part of the three first feet, while the fourth is entire.

Fig. 3. A dissected swimming foot, showing its attachment to the maxillary plate, the form and proportions of the joints, and mode of articulation.

Fig. 4. The broad terminal joint of the swimming foot, showing the notch at the extremity and the small terminal palette. These separated joints are of not unfrequent occurrence in strata where the *Eurypterus* is found.

Fig. 5. A transverse section of the abdominal portion of one of these fossils : the section is oblique to the body, and the appearance indicates that it has suffered little from compression. This is the only evidence observed, which shows the original form of the body.

Fig. 6. A fragment of a crustacean associated with the *E. remipes* at Waterville, the relations of which have not been determined.

PLATE LXXXIII B.

Fig. 2. The carapace and three articulations of the body of *E. remipes*, for comparison with the form of carapace of *E. lacustris* on same plate.

Geological position and localities. In the Waterlime group at Waterville in the town of Westmoreland, Oneida county; and at Wheelock's hill, Litchfield, Herkimer county, New-York.

Eurypterus microphthalmus (n. s.).

PLATE LXXX A. FIG. 7.

CARAPACE semioval, straight behind, more than two-thirds as long as wide; outline regularly curved. Eyes small, oval, placed much within the margins : distance between the eyes scarcely greater than between the eye and the outer margin of the carapace. First joint of the thorax narrow.

Fig. 7. The carapace, natural size, preserving a part of the first joint of the thorax.

Geological position and locality. In the tentaculite limestone, associated with *Spirifer plicatus;* from a loose fragment near Cazenovia. The associate fossil is clearly determinate of the geological position of this specimen.

Eurypterus lacustris.

PLATE LXXXI. FIG. 1 – 11; PLATE LXXXI A. FIG. 1; PLATE LXXXI B. FIG. 1 – 5; and PLATE LXXXIII B. FIG. 3.

Eurypterus lacustris : HARLAN, Trans. Geol. Soc. Pennsylvania, Vol. i, pa. 98, pl. v : 1834.
— — : Idem, Med. and Phys. Researches, p. 297.
— — : HIBBERT, Trans. of the Royal Society of Edinburgh, Vol. xiii, pl. xii.
E. remipes : RŒMER, Dunker und Von Meyer, Palæontographica, Vol. i, p. 18.
— — : PICTET, Traité de Paléontologie, Tome ii, pa. 29, pl. xlvi, f. 14 : 1853.
— — : BRONN et RŒMER, Lethea, 3d edition, 1854, vol. ii, pa. 666, pl. ix^a, f. 1.

Not *E. remipes* of DEKAY.

Not *E. lacustris*, SALTER, Quart. Journ. Geol. Soc. London, Vol. xv, p. 235 : 1859.

CARAPACE broad, somewhat straight in front and upon the sides, about two-thirds as long as wide. Eyes depressed, reniform or subelliptico-reniform, concentrically striated. Body robust, ovato-lanceolate : thoracic portion a little wider than the carapace, and perceptibly narrowing at the fifth and sixth articulations; below which, at the commencement of the abdominal portion of the body, there is a marked contraction. The first seven joints from the head are of nearly equal length and extremely transverse, being seven or eight times as wide as long : the posterior articulations are subquadrate, and the one preceding the tail-joint is longer than wide. The tail-joint is prolonged into a strong triangular spine, which is somewhat obtuse at the extremity, and the angles finely serrate.

The posterior lateral angles of the joints, from the sixth to the tenth, are usually salient, and projecting backwards in a spiniform process. The three first pairs of feet are similar in form, consisting of broad strong joints; the angles of the more extreme joints (and perhaps of all) furnished with smooth spines, usually on one side, while the two preceding the last one are furnished with a spiniferous process on each distal angle; the last joint being a simple smooth chelate tip. Each pair in succession is a little longer than the preceding, and the third pair proportionally longer than the second. The fourth pair is more slender, but strongly jointed; fully once and a half as long as the third : the last joint is a long smooth slender chela, and each of the distal angles of the penultimate joint is furnished with a slender chelate tip, while the other joints of the same have shown no such processes.

The swimming feet are strongly articulated to broad rhomboidal maxillary plates : the anterior distal angles of the [third], fourth, fifth and sixth joints are acutely angular, and project over the next joint in advance; the first joint is broadly dilated, and the penultimate is ovate and shorter than its preceding. The two joints forming the pincers are nearly as long as the five preceding joints, including the maxillary plate. The terminal palette is very minute, and, inserted into the notch at the extremity, scarcely extends beyond it. The anterior edges of these joints sometimes show serratures.

The post-oral plate is ovato-cordiform : crust thin, often finely wrinkled or striated, and both the dorsal and ventral sides of the thorax and abdomen are marked by the peculiar scaly surface. On the dorsal side these scale-like processes become developed into spiniform pustules, arranged in longitudinal rows down the back; there being usually four, and rarely five or six rows visible on the thoracic segments, while the abdominal segments preserve but two such rows. This feature is not always visible, and the scales of the intervening parts are sometimes so prominent as to interrupt the visible continuity of the lines.

The greater number of specimens examined are imperfect, and but a single specimen has shown the limbs entire.

This species differs from *E. remipes* in its greater size, and less abrupt attenuation towards the tail, while the carapace is proportionally broader and shorter. There are likewise differences in the anterior feet, and in the form of the postoral plate; the entire form of this latter appendage not having been fully determined.

PLATE LXXXI.

Fig. 1. A young individual, preserving but one of the larger appendages on one side : the posterior spine is broken off near the distal extremity.

Fig. 2. An individual of medium size, preserving all the articulations of the body, the fourth foot, and one of the swimming feet imperfect.

The specimen lies upon the stone with the back downward, and the crust from the lower side is almost wholly removed, so that the inner sides of all the parts are seen, and the cavities of the eyes. The last joint of the swimming foot is separated at the articulation (*r*), and the suture at the base of the fixed ramus of the chela, which is naturally solid, is slightly separated (*s*). The other joints are somewhat distorted by pressure, which has been directed from below upwards. On the right side of the figure, and on the last articulation, there are small portions of the ventral crust remaining. In this specimen, the interior of the crust being seen, the imbrication of the rings of the body is reversed.

Fig. 3. The exterior of a head or carapace of a larger individual, which preserves the eyes.

Fig. 4. The two posterior annulations of the body, with the caudal spine attached. The specimen lies with the dorsal side downwards; the ventral crust being removed from the annulations, and the lower *concave* side of the caudal spine is shown.

Fig. 5. A separated caudal spine, showing the lateral and lower sides. The specimen is much compressed.

Fig. 6. The ventral side of the body, preserving nine of the segments : the upper two are joined by a close suture, and sustain a locomotive [?] appendage.

Fig. 7. The upper thoracic segment separated from the body, and scarcely showing the suture line : the articulated appendage is imperfect.

Fig. 8. A very large thoracic segment, showing the suture line and the appendage before mentioned, from which the lower articulations are separated. The continuation is drawn from the one shown in fig. 6.

Fig. 9. A single articulation of the thorax. The line near the upper margin, including a portion which is broken off, indicates the extent of the imbrication of the next superior segment.

Fig. 10. A part of a segment which is longitudinally divided; a feature shown along the dorsal line in several articulations in another nearly entire individual*.

Fig. 11. A portion of the surface of fig. 8 enlarged.

PLATE LXXXI A.

Fig. 1. A large individual which is deprived of the appendages, except one dismembered swimming foot. The specimen is compressed, and the little pustule-like scales have the appearance of pores in the crust†.

Individuals of this species frequently attain a larger size than this, as seen in other figures.

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* It is probable that this dehiscence of the rings along the back is connected with the process of casting the crust.

† These have been very incorrectly represented in the drawing; there being but two rows, and these not parallel, on the six posterior joints, while the six rows are but indistinctly visible on a few of the thoracic segments.

PLATE LXXXI B.

Fig. 1. A specimen of medium size, lying with the dorsal side exposed. The carapace has been broken off, showing the inner side of the maxillary plates, the post-oral plate, and the four anterior pairs of feet, which are obscured at their bases. The body is curved, and the tail-spine directed forwards. The pustuliform scales upon the back are in four rows on the thoracic joints, and two slightly diverging rows on the abdominal joints.

Fig. 2. The last joint of the swimming foot, with the minute palette at the extremity.

Fig. 3. The seventh joint of the swimming foot, having the triangular chelate extension separated at the suture.

Fig. 4. The first articulation of the ventral side, with the organs attached.

Fig. 5. A portion of the surface enlarged, showing the scale-like markings.

PLATE LXXXIII B.

Fig. 3. The carapace of a large individual, showing the form to be distinct from fig. 2, which is the carapace of *E. remipes*.

Geological position and locality. In the Waterlime group : Near Williamsville, and near Buffalo, Erie county, New-York.

Eurypterus lacustris, var. robustus.

PLATE LXXXI C. FIG. 1.

CARAPACE comparatively small. Body very robust, elongato-ovate. Joints of the thorax broad and strong, their width being from four to six times their length. Caudal segments increasing rapidly in length : terminal spine unknown. The central locomotive appendage of the first joint of the thorax is obsolete or imperfectly developed. The three anterior pairs of feet strong and short-jointed, the first pair reaching little beyond the margin of the carapace ; the fourth pair extending far beyond the carapace : joints long, and thickened at the distal extremity ; postoral plate oval-ovate, broader anteriorly and slightly emarginate in front; maxillary plates broad, rhomboidal. The second and third joints are obscured ; the fourth, fifth and sixth are well preserved, and show the prolongation of the anterior edges in short spine-like processes over the next joint, which, exclusive of the soldered piece, is little longer than wide : the eighth joint is oval-ovate, about twice as long as wide, bilobed at the tip for the reception of the terminal palette, which is small and scarcely exsert.

This species has been referred to *E. lacustris*, and the resemblance is very close. The form of the anterior feet and the swimming feet are essentially the same, while the joints of the body are proportionally longer and stronger; furnishing sufficient ground for a variety, but not satisfactory evidence of specific difference.

Fig, 1. View of the specimen from the lower side.

Geological position and locality. In the Waterlime group, near Buffalo.

Eurypterus dekayi (n. s.).

PLATE LXXXII. FIG. 1.

CARAPACE semicircular, length being to the width as 11 to 19, anteriorly and laterally margined by a slightly elevated rim. Body broad, ovato-lanceolate; length, including the tail-spine, a little more than twice and a half the greatest width; width across the thorax greater than the base of the head, gently narrowing at the fifth and sixth segments, and below this more abruptly contracted. The first six segments are plain, and rounded at their lateral margins; those below are imbricate with mucronate extensions, while the last one is alate on each of its lateral edges, and is extended at its posterior angle in mucronate or spiniform processes over the base of the tail-spine. The abdominal joints gradually increase in length to the eleventh, and the twelfth is twice as long as the preceding. The tail-spine is triangular, as long as the five preceding joints, and, in its present condition, concave along the upper side, with the angles apparently free from serrations.

POSTORAL PLATE suboval, greatest width a little above the middle, the anterior end concave. The pairs of feet originate a little anterior to the middle of the carapace : the basal joints are short; the maxillary plates broad and strong; the coxa is wide and short (the succeeding joints are not discernible in the individual) : the fourth, fifth, and sixth joints have their distal angles strongly mucronate; the seventh joint is abruptly dilated, comparatively broad and short, while the movable chela is likewise short and broad, and the terminal palette small. The central thoracic appendage reaches to the fourth articulation, with the terminal processes short.

This species differs conspicuously from all the others, in many points of importance. The entire body is proportionally shorter, the carapace shorter and broader, than in *E. remipes*, and less contracted than in *E. lacustris*. The swimming feet are shorter, and the terminal palette a little more developed than in *E. remipes* or *E. lacustris*; and the upper abdominal joints differ less from the thoracic joints in length, while the last one is alate on the two lateral edges, a feature not observed in any other species. The tail-spine is concave above for its whole length, with a little triangular elevation in the middle at the base. This concavity may perhaps be the effect of pressure, but no other species has shown a similar feature. The absence of serrations may be due to the exfoliation of the crust. The entire animal is more compact, and all the parts are shortened, with the proportions expressive of great force and strength.

A single specimen of this species only has been observed.

Fig. 1. The individual, natural size, with the dorsal side upwards. One side has been broken off; and this portion, with the swimming foot, is restored in outline, the same organ on the left side being essentially entire. The upper part of the carapace and the first joints are removed, so as to show the maxillary plates, the postoral plate and the bases of the anterior feet, which are broken off so as not to extend beyond the margin of the carapace. The thoracic appendage is shown in its junction with the first ventral joint, and extending to the base of the fourth joint.

Geological position and locality. In the Waterlime group at Blackrock, New-York.

Eurypterus pachycheirus (n. s.).

PLATE LXXXII. FIG. 1 – 3.

CARAPACE unknown. Body robust: crust thick; articulations strong, those of the abdomen extended in strong salient angles at the lateral edges. Bases of the anterior feet strong and broad. Swimming feet strong and large; the seventh [sixth] joint very large and long, inflated and much curved on the anterior side: the free eighth joint is thick and strong, somewhat oval, and narrowing gently towards the point of articulation; the terminal palette is small. The last joints (and perhaps the others) of the swimming feet are serrated on the margins.

No entire specimens of this species have been seen, and the description is drawn from an imperfet specimen preserving eleven articulations of the thorax and abdomen, measuring altogether five and a half inches in length, and three and a quarter inches the greatest width. On the same specimen are preserved some fragments of the carapace, the bases of the feet, parts of the maxillary plates, and a joint of the

swimming foot. On another specimen, from the same locality, is a swimming foot preserving the fourth, fifth, sixth, seventh and eighth joints, with the terminal palette. The peculiar arching of the seventh [sixth] joint, and the thickened or inflated character of the swimming foot in this species, appear to be sufficiently characteristic to rely upon for specific distinction. The joints of the thorax and abdomen have the scaly surface marking more strongly developed than any other species observed; and the anterior margin of each joint, which is imbricated by the one before it, is raised in a little elevated band, more prominent and more strongly serrate on its posterior edge than any of the other species. The surface is likewise marked by strong longitudinal wrinkles somewhat irregularly disposed. The last four joints are marked by a double row of scale-like pustules, as in other species.

Fig. 1. The body of an individual of this species, preserving eight or nine articulations of the thorax and abdomen. The surface is strongly marked by the scale-like facets, and the articulations are coarse and strong.

Fig. 1 *a*. A portion of the crust enlarged, showing the surface markings.

Fig. 2. A fragment of stone upon which are preserved two swimming feet, the anchylosed ventral thoracic segment, and some portions of the anterior feet. These appear to be the remains of a large individual, which has been broken up, and the parts separated. The swimming foot 2 *a* shows the lower side, and the joints are partially separated; and fig. 2 *b* shows the lower side of the other foot, also in a reversed position.

Fig. 2 *c* is the fragment of one of the anterior feet, and fig. 2 *d* is the same placed in a natural position: the length of the spines is a very characteristic feature.

Fig. 2 *e* is the anchylosed first and second segments on the ventral side, preserving the thoracic appendage. The specimen is worn, and the line of suture is scarcely perceptible.

Fig. 3. A separate swimming foot, preserving the five outer joints.

Geological position and locality. In the Waterlime group at Blackrock, and four miles east of Buffalo.

Eurypterus pustulosus (n. s.).

PLATE LXXXIII B. FIG. 1.

CARAPACE very wide, somewhat semicircular, broadly rounded in front, with posterior angles rounded and a little extended laterally. Eyes broad reniform, distant from each other, and almost equidistant from the lateral and anterior margins.

SURFACE pustulose; the pustules of very variable size, and sometimes assuming a scale-like form. Crust comparatively thick.

The specimen consists of an imperfect carapace, with a part of the first joint of the thorax remaining on one side, which is pustulose in the same manner as the carapace. There are some intervals on the surface of the carapace, between and behind the eyes, where the pustules assume a somewhat scale-like form, similar to the rows of scale-like pustules down the back of the animal.

Fig. 1. The specimen, natural size.

Geological position and locality. In the Waterlime group, near Buffalo.

EURYPTERUS, Subgenus DOLICHOPTERUS.

CEPHALIC, thoracic, and caudal portions of the body similar to EURYPTERUS. Postoral plate lyrate or cordiform-lyrate; the central thoracic appendage, from the first thoracic segment, strong, thick and simple in its anterior part; extremity? Anterior feet composed of strong thick joints, with curved terminal spines: posterior or natatory organs having the joints elongate, the seventh and eighth little dilated, and the terminal palette extremely developed.

The principal differences from EURYPTERUS are in the development of the palette, the less dilatation of the natatory feet, the form of the postoral plate, and the central foot-like organ.

Dolichopterus macrocheirus (n. s.).

PLATE LXXXIII. FIG. 1; and PLATE LXXXIII A. FIG. 1.

CARAPACE semioval, somewhat straight in front; sides straight for more than half the length from the base; length and breadth about as 9 to 10. Eyes large, oval, distant, placed far forward and nearer the anterior than the lateral margins of the carapace. Body elongate ovato-lanceolate, gradually contracting to the base of the first five joints, and more abruptly below the sixth. The joints of the thorax are strong, and six or seven times as wide as long; the ninth, tenth and eleventh segments are proportionally much longer, the last one quadrangular. The margins of the abdominal joints are but slightly imbricated. The anterior feet

are very thick and strong, and the joints comparatively short, having their origin at about the anterior third of the carapace. Postoral plate lyrate, with the anterior cordiform. Maxillary plates rhomboidal, more than one-half longer than wide; the inner anterior extremities extending beyond the postoral plate, and distinctly serrate. Second joint strong and wide; third joint very short; fourth joint about twice as long as wide; fifth and sixth joints nearly one-fourth longer than wide; seventh and eighth comparatively short, as wide as long; the fixed chela very small. The terminal palette is excessively large, ovate, longer than the preceding joint, and nearly as wide. The thoracic appendage is articulated to the first thoracic articulation in the usual manner: the lower margin of the first joint adjacent to this organ is prolonged in triangular extensions over the next joint; the appendage itself extends to the fifth joint of the body, and is imperfect at the extremity.

CRUST very thin. No scale-like markings have been observed, nor rows of scale-like pustules along the dorsal side.

The simple chelate appendages or spines of the anterior feet are remarkably thick and strong, and were apparently more numerous than in the other species. The extensions or anterior edges of the last joints of the swimming feet are very strongly serrate.

This species is distinguished by its robust elongate body, the long straight-sided carapace, very anterior eyes, strong and thick-jointed anterior feet, and extremely long swimming feet, with the great development of the terminal palette, and the little dilatation of the two preceding joints. The form of the postoral plate is very remarkable, though its posterior termination is unknown: the appendage is more prolonged and of a different form, and the adjacent articulation is very peculiar; and there are distinctive features in the maxillary plates.

A single specimen only has been seen.

PLATE LXXXIII, fig. 1. The dorsal side of the specimen, preserving ten joints and a part of the eleventh joint of the body.

PLATE LXXXIII A, fig. 1. The ventral side of the specimen as it lies on the surface of the stone.

Geological position and locality. In the Waterlime group near Buffalo.

GENUS PTERYGOTUS (AGASSIZ).

THIS genus was established by Prof. AGASSIZ in 1844, in his "Monographie des poissons fossiles du vieux grès rouge". The specimens then known were all fragmentary; and although some additional facts were from time to time obtained, it was not until 1856 that Mr. SALTER published* an illustration of the restored form of the animal, under the name *Himantopterus*, which he subsequently determined to be identical with *Pterygotus*.

The form is very similar to *Eurypterus;* the eyes being marginal instead of within the carapace, while the caudal extremity is bilobate†. The number of segments of the body, as represented, is one less than in *Eurypterus;* but this may have arisen from observing the lower side only, and the suture, if existing as in *Eurypterus*, may not have indicated a separate articulation. One other remarkable difference between this genus and *Eurypterus* is in the "*chelate antennæ*" placed at the anterior part of the carapace; a relation which seems scarcely credible, but for the authority under which it is presented.

A fragment, the free ramus of one of the chelate antennæ‡ of a species of this genus, has been found near Buffalo by Mr. COBB; and in the same collection with it there is a single joint, apparently a caudal joint, which differs from any similar part of *Eurypterus* known to me at this time.

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* On some new Crustacea from the uppermost Silurian rocks, by J. W. SALTER, F.G.S.; with a Note on the structure and affinities of *Himantopterus*, by T. H. HUXLEY, F.G.S. (Quarterly Journal of the Geological Society, Vol. xii, p. 26.)

† The spiniform caudal appendages, figured on the same page as belonging to this genus, may prove to be *Eurypterus*.

‡ Chelate antennæ of HUXLEY and SALTER. Notwithstanding that these organs are placed at the anterior part of the carapace, and in the position of antennæ, the similarity of structure in *Pterygotus* and *Eurypterus* induces me to believe that other relations of these parts will yet be found; and that chelate antennæ of this character, and in this position, do not belong to *Pterygotus;* or else that we have misunderstood the specimens referred to this genus among our collections. The many structural analogies between these crustaceans and *Limulus* would induce me to regard these organs as analogous in some measure with the chelate antennæ [palpi] of that animal, and as having a similar position anterior to the mouth.

Among the collections from Waterville there is a fragment preserving four thoracic segments, the basal joints of the swimming feet, the post-oral plate, and the remains of four smaller feet analogous in position to those of *Eurypterus*, but more slender and with longer joints; the thoracic segments also are proportionally longer. The first of these preserves some remains of the central organ noticed in *Eurypterus*. The bases of the larger first joints of the swimming feet, and the bases of the smaller ones, are serrate or toothed, and the place of the mouth is distinctly seen. There are no evidences of the anterior chelate organs, designated *antennæ*, and it otherwise differs from the figures of *Pterygotus* (*Himantopterus*) as given by Mr. SALTER. At the same time the fragment affords scarcely sufficient knowledge of the structure to separate it from that genus.

A single small carapace from Litchfield, Herkimer county, preserves very broadly oval eyes, which are situated on the antero-lateral margins, and differing in no particulars, except their position, from the eyes of *Eurypterus*: it has likewise two small central oculiform tubercles. I refer this with doubt to the Genus PTERYGOTUS*.

Pterygotus cobbi (n. s.).

PLATE LXXXIII B. FIG. 4; and PLATE LXXXIV. FIG. 8?

CARAPACE and body unknown. The specimen is the free ramus of a chelate appendage, consisting of a thin crustaceous substance; it is broad and flattened at its articulating extremity, gradually narrowing towards the

* It is only as these pages are going through the press, that I have seen the monograph of Messrs. HUXLEY and SALTER on the *Pterygotus*, published this year (1859); and I can only regret that I could not have seen this elaborate work before preparing my own observations. Mr. HUXLEY has taken great pains to point out the errors of Prof. AGASSIZ, and others who have preceded himself, in reference to the location of the separated fragments and the restoration of parts in this fossil; and it would have been well had he made himself quite sure of the relative position of some parts in his own specimens, before publishing these criticisms. The misinterpretation of the location and functions of the thoracic joint and its central appendage, is an error of equal magnitude with any that he has pointed out. Those who have been pioneers in a work of this kind, and who have pressed their way into an unknown region where, before, there was no guide or landmark, should be judged leniently by those who follow the same road, made bright with the records and studded with the beacons of their laborious predecessors.

distal end, and strongly incurved. It bears on its inner edge six strong but unequal teeth, which preserve slight marks of longitudinal striæ visible under a lens.

On another part of the same stone there is an elongate striated surface, partly the substance and partly an impression, which may have belonged to this chelate organ.

The caudal segment, referred with doubt to this species, is about one and a half inches long and two inches wide : the surface is ornamented by small, pointed, imbricating, scale-like processes, which are distant from each other, and the intermediate spaces granulose.

This ramus of the chelate appendage was the first unequivocal fragment of the Genus PTERYGOTUS that came under my notice from any American locality, having been known to me since 1854.

PLATE LXXXIII B, fig. 4. The free ramus of the chelate appendage of this species.
PLATE LXXXIV, fig. 8. An articulation of the abdomen, which probably belongs to this or to some other species of this genus.

Geological position and locality. In the Waterlime group near Buffalo.

Pterygotus macrophthalmus (n. s.).

PLATE LXXX A. FIG. 8 & 8 *a*.

CARAPACE semielliptical, slightly concave behind; length equal to three-fourths the greatest breadth : cornea-lenses oval, marginal, and projecting beyond the outline of the carapace, concentrically striated. The distance between the eyes is less than the length of the eye. A small central longitudinally oblong tubercle lies in a line with the posterior angles of the eyes, and nearer to the base than to the anterior margin of the carapace. This small subcentral tubercle is marked on each side by a small rounded eye-like spot, nearer to the posterior end of the tubercle.

SURFACE preserving no organic markings; being merely a blackened ground, with the granular texture of the stone.

This is the only carapace which I have seen, where the eyes are marginal. In the form and appearance of the carapace, the specimen resembles others of the genus; but I am not aware that the central tubercle, with the eye-like spots, has been noticed in *Pterygotus*. A similar feature has been observed in *Eurypterus*, though not seen in all the species of the genus.

Fig. 8. The carapace, natural size.

Fig. 8 *a*. A small portion enlarged, to show more distinctly the oblong tubercle, and the small eye-like points which are faintly visible to the naked eye.

Geological position and locality. In the Waterlime group : Wheelock's hill, Litchfield, Herkimer county.

Pterygotus osborni (n. s.).

PLATE LXXX A. FIG. 9.

CARAPACE unknown. Body elongate. The four anterior joints of the thorax have a width of about four times their length. The first segment shows the point of attachment for the thoracic appendage, as in *Eurypterus*. Postoral plate elongato-cordiform. First joints of the natatory feet rhomboid-ovate, and toothed on their inner margins; the four anterior feet slender, with long joints; the basal joints broad, with long spine-like teeth. The entire length of the cephalic portions, and the four first joints of the body, is about three inches.

Fig. 9. A figure of the specimen, natural size. A reference to the parts of *Eurypterus* will explain the relations of the parts of this figure.

Geological position and locality. In the Waterlime group : Waterville, Oneida county.

CERATIOCARIS.

THE posterior or caudal spines of this crustacean have been known in our rocks from fragments in the Clinton and Niagara groups, as well as in the Waterlime group. Until their true character was pointed out by Professor M'COY of London, these fossils were regarded as the defensive spines of fishes, and were thus described. A species from the Niagara group has been described in the second volume of the Palæontology of New-York,

as *Onchus deweyi**. The structure of this fossil, under a microscope, is eminently crustacean; and from our present knowledge of this, with other fragments, spines, etc., it appears conclusive that we have several species of the genus in our strata.

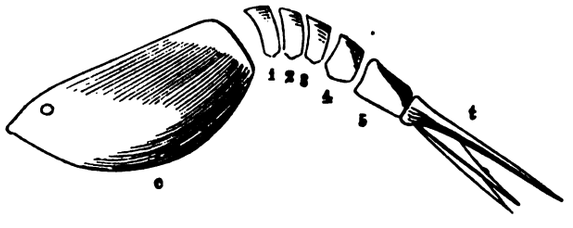
The spines, either separated, or connected (as they are when perfect) in a triple arrangement, have been termed *Leptocheles* by Prof. M'Coy; and subsequently their true relations have been discovered.

Genus Ceratiocaris (M'Coy).

"Carapace bivalved. The dorsal line simply angulated (? undivided) with "a slight furrow beneath it on each side: sides semielliptical, much "elongated from before backwards, very convex; ventral margin "gently convex, posterior end abruptly truncated obliquely. On each "side, near the anterior end, considerably below the hinge-line, is an "ocular (?) spot, sometimes raised and distinct, in some species flat. "Surface marked with fine, obliquely longitudinal imbricated striæ†."

Mr. Salter has given‡ a diagram of this fossil, "from perfect specimens found in "Lanarkshire". The accompanyjng figure is copied from the one cited.

Fig. 8.



There are five articulations, besides the triple caudal spine. In our specimens, the relations of the three spines differ somewhat from that represented in the figure, as will be seen by reference to the plates.

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* Page 320, Plate lxxi, fig. 1.

† British Palæozoic Fossils, p. 186.

‡ Quarterly Journal of the Geological Society of London, Vol. xii, p. 38.

Among the collections made by Mr. COBB from localities near Buffalo, there are fragments of a species of this genus, and two specimens lying in such a position that we may suppose the carapace to have separated on the lower side, and the abdominal and caudal portions to have been folded forward between the valves of the carapace, leaving the tail-spines projecting beyond the anterior end.

Ceratiocaris maccoyanus (n. s.).

PLATE LXXXIV. FIG. 1 – 5.

CARAPACE (lateral view) subovate, a little more than twice as long as wide, obtusely pointed anteriorly, and obliquely truncated behind: basal margin gently curving from the basal posterior edge to the anterior end. The carapace appears to be composed of two valves, anchylosed along the dorsal line, in the perfect condition. The articulations near the tail are narrow and long, the spines short, and the upper or dorsal one is little longer than the lower one, while the latter apparently closes in a groove or depression between the other two. The surface of the carapace is concentrically striated.

Fragments of five individuals of this species are known: two of them preserve the carapace; and the three others are the posterior joints, with the tail-spines partially or entirely preserved.

Fig. 1. A specimen preserving the tail-spines, several articulations of the body, and a part of the carapace, the body having been folded between the valves of the latter.

Fig. 2. A specimen in similar condition, preserving one side of the carapace more nearly entire.

Fig. 3. A fragment preserving the tail-spines, with two or three of the articulations.

Fig. 4. A similar fragment.

Fig. 5. A similar but larger fragment.

Geological position and locality. In the Waterlime group, near Buffalo.

Ceratiocaris acuminatus (n. s.).

PLATE LXXXIV. FIG. 6.

CARAPACE somewhat rhomboid-ovate; width a little less than one-half the length : posterior articulating margin less than half the greatest width in the middle. From the postero-basal margin the outline is gently curved downwards for about three-sevenths of the length, and then turns more abruptly upwards and forwards, the anterior end terminating in an acuminate process. Posterior and basal margins marked by a narrow raised border. Dorsal margin very slightly curved for three-fourths the length, the anterior fourth being more abruptly bent downwards to the pointed extremity.

SURFACE somewhat strongly striated concentrically.

This species differs in having a proportionally greater width than the preceding.

Fig. 6. The left valve of the carapace of this species.

Geological position and locality. In the Waterlime group, near Buffalo.

Ceratiocaris : sp.?

PLATE LXXXIV. FIG. 7.

The figure represents a crushed specimen, which preserves the mutilated carapace and several of the articulations, but too indistinct to be determined : it may be identical with the preceding.

Ceratiocaris aculeatus (n. s.).

PLATE LXXX A. FIG. 10.

LAST joint of the abdomen or tail thick and rounded : the larger tail-spine rounded, very strong at the base, and grooved for the reception of the smaller spines.

This specimen is associated with some fragments of the posterior joints, in the same rock with *Eurypterus remipes*. It differs from the preceding species in being larger at base, and strongly grooved : the fragments of the crust associated with it are strongly striated.

Fig. 10. The posterior joint of the body and tail-spines.

Geological position and locality. In the Waterlime group at Waterville.

For the means of making these examinations and comparisons of numerous specimens of the different species of Eurypterus, I have been indebted to several gentlemen for the loan of specimens from their private collections.

Some years since, Mr. Osborne of Waterville presented me with a small collection of specimens of *Eurypterus remipes*, the study of which has revealed some interesting points in the structure of these fossils.

To Col. E. Jewett, I am indebted for the use of several interesting specimens. The State Collection has furnished the only illustration of *Eurypterus dekayi*, and the principal illustration of *E. pachycheirus* and some others. The very fine collection of Mr. C. Cobb of Buffalo has supplied means of illustration for *E. lacustris* and others, and also for the peculiar form *Dolichopterus* (Plates lxxxiii and lxxxiii a). To the same collection I am also indebted for the large fragment of *Pterygotus*, and some illustrations of *Ceratiocaris*.

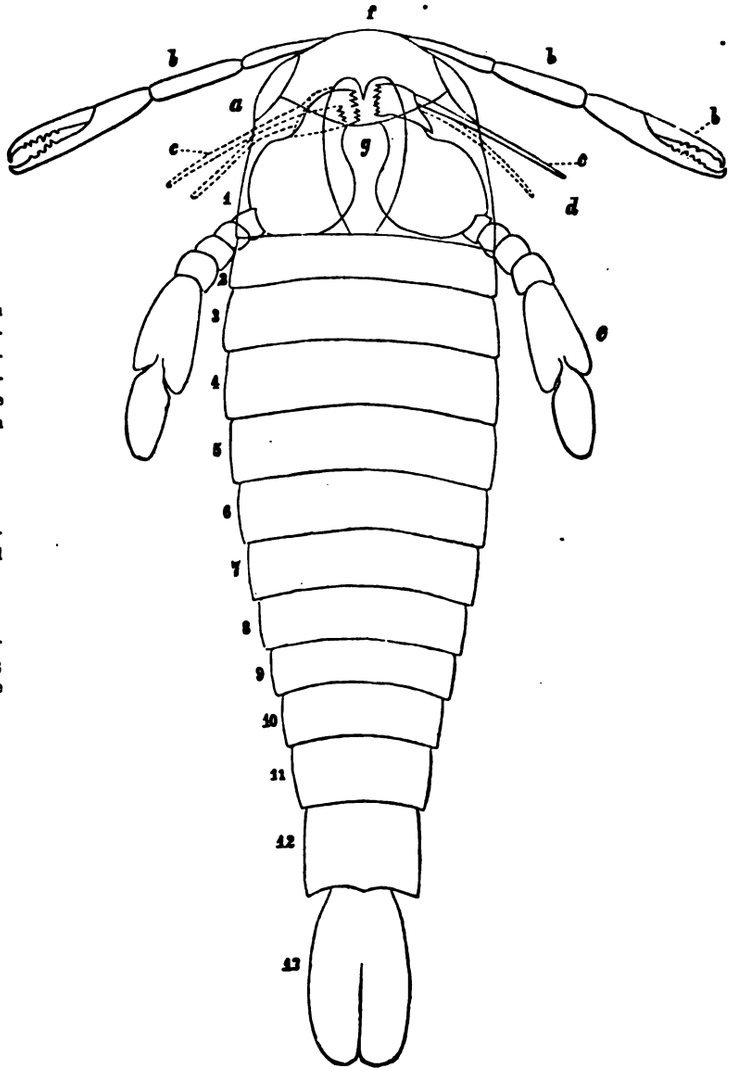
I regret extremely that I could not have had the means of exploration in the strata from which these specimens were obtained; for great as is the advance made in our knowledge of these interesting fossils to the present time, there is yet much to be done in bringing to light more perfect individuals of the forms already known, and of adding new species.

The facts deduced from the observations I have been able to make, indicate that these animals were restricted in their geographical distribution; that they congregated in large numbers in the localities where we find them, or at least that their remains indicate the existence of large numbers of individuals in proximity to the localities where they occur; though it is probable that many specimens, particularly of dismembered parts, were the cast-off coverings of living animals.

SUPPLEMENTARY NOTE ON THE GENUS PTERYGOTUS.

THE monograph of Messrs. HUXLEY and SALTER, referred to on page 417*, furnishes the accompanying illustration of the Genus PTERYGOTUS; being a restored diagram of *P. bilobus*, of the natural size.

The figures and letters, with the reference to the parts, and the nomenclature employed, are copied from the explanations of the figure in that monograph.



a. Eyes.

b. Antennæ.

b'. Chela.

c. The endognaths with their palps: their basal joints are, for distinctness' sake, represented as if they were widely separated in the middle line.

d, *e*. The ectognaths, with their palps.

f. The epistoma, or conjoined epistoma and labrum.

g. The metastoma.

1 – 13. Successive segments : 1, carapace; 2 – 12, segments of the body; 13, telson.

ORISKANY SANDSTONE.

The Oriskany sandstone everywhere succeeds to the upper members of the Lower Helderberg group, and, at several points, extends beyond the known geographical limits of the latter. In the greater number of localities within the State of New-York, the transition from the upper calcareous beds of one group to the siliceous or sandy beds of the other is very abrupt; while in other instances there is an intermingling of calcareous matter in the lower beds of the sandstone. In these instances, however, as well as in others, the siliceous material appears to have been to a considerable degree in the condition of gelatinous silex, producing a rock approaching in character to hornstone; while other examples present an appearance as if the grains of silex had been softened, or agglutinated by a siliceous paste. In its more fossiliferous parts the rock is a mixture of silica and carbonate of lime; and the action of the weather, dissolving and removing the latter, leaves a grayish brown porous mass, embracing the casts of the interior and moulds of the exterior of the fossil shells. In many places the rock consists of a sandstone of nearly pure white, or graduating from white to buff-colored : in more southern localities, it often presents the aspect of a siliceous limestone, not differing greatly from the succeeding limestones.

While in the State of New-York the accessible portions of the rock furnish us for the most part with casts of its fossils, or, if beyond the reach of weathering, with a compact mass of calcareous sandstone in which the fossil remains are closely imbedded, we find, in Maryland and

some parts of Virginia, that in the friable sandstone the shells are entirely silicified and quite free from adhering stone, so that the exterior markings and internal structure are perfectly preserved; the interior being quite hollow, or filled only with loose sand. In these localities, not only do we find the cavities of large gasteropods with no more adhering matter than those of the Tertiary sands, but not unfrequently the delicate internal apparatus of the Brachiopoda is almost entirely preserved; furnishing means for the determination of several genera, which the collections from all other parts of the country have failed to show.

The great changes in the physical conditions supervening at the close of the preceding group indicate an influence which would affect in an equal manner the fauna of the succeeding one, and we find accordingly few species passing from the Lower Helderberg group to the Oriskany sandstone. The changes, however, are mainly of a specific character; no new genera being introduced, so far as we now know, though some of them appear under modified forms.

Amongst the Brachiopoda, *Orthis*, *Strophodonta*, *Chonetes*, *Strophomena* and *Leptæna*, *Spirifer*, *Cyrtia*, *Rhynchonella* and *Merista* are genera which occur equally in this formation and in the preceding and succeeding ones. At the same time the Genera *Rensselæria*, *Eatonia* and *Leptocœlia* are more fully developed than at any former or succeeding epoch. Of the Genus LEPTOCŒLIA we have one species in the Niagara group and two in the Lower Helderberg group, two of larger size in the Oriskany sandstone, and one or two in the succeeding rocks. Of the Genus EATONIA we have four species in the rocks of the Lower Helderberg group; and we do not at present know more than an equal number in the Oriskany sandstone, though they are more abundant in the latter rock, and one species is larger than the largest of the Lower Helderberg species. Of the remarkable form RENSSELAERIA we have four species in the rocks of the Lower Helderberg group, while the genus becomes excessively developed in the Oriskany period; not so much, however, in the number of species, as in their large size and the great number of individuals. We already know three species of this genus in rocks above the Oriskany sandstone.

Among the Lamellibranchiata we have a few aviculoid forms, which, except in their size, form no marked contrast with those which preceded or those which follow.

In the Gasteropoda, I have already shown* that the Genus PLATYOSTOMA, in its typical species, occurs both in the Lower Helderberg rocks and in the Oriskany sandstone, while it is also known in the higher formations. The STROPHOSTYLUS is equally characteristic of the Lower Helderberg limestones and of the Oriskany sandstone, though at present not well determined in the higher formations. The PLATYCERAS, in several forms, is quite abundant in the Oriskany sandstone; two or more of the species being common to this rock and to the Lower Helderberg limestones. We have likewise the casts of two spiniferous species in this rock, showing their affinities with those of the Upper Helderberg limestones.

It is not possible, therefore, to point out any changes in the fauna of this period sufficient to indicate the commencement of a new system, and its relations with the formations below are as intimate as with those above; while in the Northern and Middle States, the Oriskany sandstone bears in its fauna a closer relation to the lower than to the overlying formations. It is, moreover, in the State of New-York, separated from the succeeding fossiliferous rocks of the Upper Helderberg group by the non-fossiliferous or almost non-fossiliferous belt of the Cauda-galli grit, which often attains a thickness of one hundred to one hundred and fifty feet.

The order is as follows:

SCHOHARIE GRIT : Lowest member of the Upper Helderberg group.

CAUDA-GALLI GRIT : Non-fossiliferous.

ORISKANY SANDSTONE.

UPPER PENTAMERUS LIMESTONE : Highest member of the Lower Helderberg group.

It may be regarded that the physical conditions which inaugurated the Oriskany sandstone prevailed through the period of the Cauda-galli grit, disappearing in the Schoharie grit and succeeding limestones. It is not

* See page 308 of this volume.

only possible to conceive, but highly probable, that as we approach the source of the sedimentary matter marking the beginning of the Oriskany period, we may find the same or similar physical conditions prevailing throughout a long period, and uniting by insensible gradations and alternations of the sedimentary material the lower and the higher groups. When, therefore, we observe the absence of the Upper Helderberg limestones in some eastern localities, and the coarser sedimentary character of much of the Hamilton group and succeeding formations, we are prepared to understand how, in the absence of calcareous deposits, we may have a continuation of sedimentary formations from the base of the Oriskany sandstone to the Coal period; a condition which actually does exist in some parts of Pennsylvania, though marked at intervals by changes indicating lines of separation between groups which are elsewhere more strongly characterized.

From the Reports of the Canadian Geological Survey, we learn that the physical conditions in the northeastern part of that territory, from the beginning of the Oriskany period, continued with little change through a long interval, and so uniform as to have prevented, up to the present time, the establishment of any lines of subdivision among the strata, which, in their lower part, bear fossils characteristic of the Oriskany sandstone, and in their higher members those which mark the period of the Hamilton and Chemung groups of New-York.

Therefore while in the central part of their extent we must regard the Oriskany sandstone as more closely allied in its fauna to the lower rocks, we find, in other localities both in Pennsylvania and in Canada, in the absence of the calcareous members of the higher groups, a more intimate relation between the Oriskany sandstone and the succeeding sedimentary formations; making it, in fact, under these circumstances, the base of a set of strata which culminate in a period favorable to the production of land plants, and which again in other parts, in the absence of calcareous beds, form an unbroken series to the base of the Coal measures.

These relations are important for consideration; since, in the classification of the palæozoic rocks, geologists are at the present time inclined

to place the Oriskany sandstone as the first or lower member of the Devonian system, thus uniting it with the rocks above rather than with those below.

The Oriskany sandstone is recognized throughout the entire extent of the Appalachian chain, having its greatest development in that direction. In New-York it has been traced continuously, or with unimportant interruptions, as far west as Cayuga lake, at which locality it is fossiliferous. It has likewise been recognized at other points in Ontario county, in small lenticular patches; and at one point still farther west, in some nodules of dark-colored non-fossiliferous sandstone which hold the position and preserve the character of the Oriskany sandstone in other localities.

Some years since, this rock was noticed by Mr. MURRAY, of the Canada Geological Survey, in Canada West; and, more recently, Mr. BILLINGS, the Palæontologist of that Survey, has collected from this rock, in Cayuga county (Canada West), a considerable number of its characteristic fossils.

Mr. WORTHEN, the State Geologist of Illinois, has observed a sandstone in that State holding the place of the Oriskany sandstone; and has collected from this rock, on the Mississippi river, some of the characteristic fossils, leaving no doubt as to the identity of these distant outlying masses with the great continuous formation at the East.

In Iowa, on the west of the Mississippi, the upper beds of the Onondaga salt group are waterworn, indicating a lapse of time previous to the succeeding deposit, and are sometimes scattered over with coarse sand or gravel, presenting thin films of conglomerate; but no continuous stratum has been observed. From the relative position of the two rocks, it seems not improbable that these films of sand and patches of conglomerate are due to those causes which have produced elsewhere, at the same period, the Oriskany sandstone.

CRINOIDEÆ OF THE ORISKANY SANDSTONE.

The Crinoideæ of this rock are described in connection with those of the Lower Helderberg group in the first part of the volume (See page 138). The plates (85, 86, 87 & 88) illustrating these fossils are arranged in their order of sequence among those of the Oriskany sandstone.

BRACHIOPODA OF THE ORISKANY SANDSTONE.

The generic identity of the Brachiopoda of this rock with those of the Lower Helderberg group has already been noticed. The most marked difference consists in the generally larger size of the species of the same genera, and in the great number of individuals of the same species; while the absence of Pentamerus (with the exception of an obscure specimen) from the strata of this age in New-York is remarkable, and the Genus Merista, so far as we at present know, is represented onlyin a single species.

Discina grandis (n. s.).

Plate XCII. Fig. 1 *a*, *b*, *c*, *d*.

Shell suborbicular or very broadly oval. Dorsal valve very convex, the convexity equalling about one-third of the width : apex subcentral. Ventral valve nearly flat : apex somewhat excentric, very slightly elevated in front of the foramen, and the space between this and the anterior margin slightly concave; foramen oblong, narrow oval, the depression on the exterior of the shell extending from the apex to near the posterior edge.

Surface marked by strong elevated concentric lamellose striæ, and, on the interior of the shell, by radiating vascular impressions.

This species resembles the *Discina discus* of the Lower Helderberg rocks; but it is much larger than any specimen of that species observed, the concentric lamellæ are much stronger, and the specimens (which are principally casts or impressions of the exterior) do not show radiating striæ.

Fig. 1 *a*. The dorsal valve, from a cast taken from the mould of the original in sandstone.

Fig. 1 *b*. The ventral valve from the inside, the shell having been mostly removed by weathering.

Fig. 1 *c*. Profile of the dorsal valve.

Fig. 1 *d*. The ventral valve, from a cast retaining the two valves in connexion. The foramen, as seen in this specimen, extends more nearly to the margin than is shown in fig. 1 *b*, which is seen from the inside.

Geological position and locality. In the Oriskany sandstone : Helderberg mountains, Albany county.

Orthis hipparionyx.

PLATE LXXXIX. FIG. 1 – 4; PLATE XC. FIG. 1 – 7; PLATE XCI. FIG. 4 & 5; and PLATE XCIV. FIG. 4.

Atrypa unguiformis : CONRAD*.

Hipparionyx proximus : VANUXEM, Geological Report of the Third District, 1843, p. 124, f. 4.

Orthis hipparionyx : VANUXEM [?]; SCHNUR, Palæontographica (DUNKER und VON MEYER), III. Band, pag. 217, tab. xl, f. 1 *a*, *b*, *c*.

SHELL suborbicular or depressed-hemispheric; length and width nearly equal, or varying from this form to that of length and width as seven to eight (In one specimen, having a width of three inches and one sixteenth, the length is one-eighth of an inch less than the width). Dorsal valve regularly convex, the greatest convexity near or a little above the middle of the shell, and sloping evenly towards the sides and front; the margin, towards the dorsal line, a little more compressed : beak prominent, incurved. Ventral valve nearly flat, a little convex near the beak, and often slightly concave towards the front : area wide, of moderate height, flat; foramen usually closed or partially closed by a deltidium.

SURFACE marked by fine subequal striæ, which are often bifurcated and become much stronger towards the margin of the shell : slight remains

* I am at present unable to find Mr. CONRAD's description of this species, though cited by Mr. VANUXEM and traditionally known by that name among the geologists of New-York.

of concentric striæ or lines of growth are sometimes preserved. The radiating striæ on the upper lateral portions of the shell are curved towards the dorsal margin, gradually increasing in the curvature till (as shown in the cast of the dorsal valve) the direction becomes reversed.

The interior of the dorsal valve shows a very subordinate cardinal process and two strong lamellæ or brachial processes, which are joined to the shell by a ridge from the base on either side, and a well-defined median septum extending from the base of the cardinal process : the vascular impressions are not distinctly seen. The interior of the ventral valve is marked by strong muscular imprints which occupy a large cordiform space, reaching more than half and often two-thirds of the length of the shell from beak to base : the central portions, or the imprints of the adductor muscles, are often well defined. Surfaces of muscular imprint marked by large radiating grooves and ridges in old shells; while in the young shells, these markings are much less conspicuous or altogether wanting, and the outline limit of the muscular impression itself is but faintly defined along its lower margin.

This is the largest *Orthis* known to me in our rocks, and is quite equal in size to any of the Carboniferous species which have fallen under my observation. It is readily distinguished by its large and strongly marked muscular impression, which, however, presents a considerable variation in the degree of development dependent on the different stages of growth, and in some measure apparently upon the nature of the sediment in which it lived.

PLATE LXXXIX.

Fig. 1 *a*. A dorsal valve which retains a small portion of the shell. The direction of the striæ upon the hinge-margin is very well shown.

Fig. 1 *b*. Profile view of the same.

Fig. 2 *a*. A similar cast, showing the vascular impressions upon the surface of the more prominent portions, and likewise towards the anterior margin.

Fig. 2 *b*. Profile of the same from the cardinal side.

Fig. 2 *c*. The interior of the upper part of the dorsal valve and brachial processes, as shown in a mould from the preceding figure.

Fig. 4. The cast of a shell of medium size, preserving the muscular impression in its usual symmetrical form.

Fig. 3. A very old specimen, in which the muscular impression is extremely elongated.

PLATE XC.

Fig. 1. Cast of the dorsal valve of a younger specimen than that of the preceding plate.

Fig. 2. Cast of the ventral valve of a specimen of medium size, showing the lower part of the muscular impression but faintly defined.

Fig. 3. A similar specimen, which preserves a portion of the shell.

Fig. 4. An older shell, in which the cast is very perfectly preserved.

Fig. 5 & 6. The interior and the cast of a very old shell.

Fig. 7. A portion of the surface striæ enlarged.

PLATE XCI.

Fig. 4. The cardinal area, showing the closed foramen.

Fig. 5. A portion of the surface of a young shell enlarged, showing the character and direction of the striæ.

PLATE XCIV.

Fig. 4. The cast of the dorsal valve of a young shell of this species.

Geological position and locality. In the Oriskany sandstone : Albany and Schoharie counties; and along the outcrop of this rock through Herkimer, Oneida and Onondaga counties. It is likewise often found in boulders of the sandstone, which are scattered over the southern counties of the State.

Orthis musculosa.

PLATE XCI. FIG. 1, 2, 3; and PLATE XCV. FIG. 1 – 7.

Orthis musculosa : HALL, Annual Report of the Regents of the University upon the State Cabinet of Natural History for the year 1856 (published 1857), p. 46; Palæozoic Fossils, 1857, p. 6.

SHELL suborbicular, the length about nine-tenths as great as the width. Ventral valve depressed-convex, sometimes slightly concave near the front : beak prominent, equalling or extending a little beyond that of the opposite valve, pointed and slightly incurved : hinge extremely short; area triangular, extending little beyond the foramen; foramen large, partly occupied by the prominent cardinal process of the other valve : dental lamellæ strong and prominent, continued below in the elevated margin of the muscular impression, which is large, fan-shaped, and strongly marked. Dorsal valve regularly and distinctly convex, most elevated in the central region, sometimes a little flattened or depressed towards the front : beak prominent, triangular, pointed and incurved; cardinal process large, and sometimes with very slight marks of trilobation on the summit : brachial lamellæ broad and strong, and separated from the shell on each side by deep dental fossets.

SURFACE marked by fine distinct radiating striæ, those near the cardinal margin being curved outwards from the beak; concentrically marked by obscure lines of growth.

This species bears a general resemblance to *O. oblata* of the Shaly limestone; but it attains a larger size, is more ventricose, and never so distinctly resupinate. The beaks are more prominent and incurved, that of the dorsal valve curving beyond the hinge-line. The cardinal views of the two species also differ : the hinge-line of the present species arches upwards on each side of the beaks, while in the other it is straight. The area is also higher in the Oriskany species than in that from the Shaly limestone.

In the Oriskany sandstone of New-York, this species usually occurs in the form of casts. I have obtained fine specimens of the fossils entire, and of the separate valves, from Cumberland, Maryland.

The casts which I have referred to this species present some variety in the size and form of the muscular impressions; but I am unable to find any constant characters, by which a distinct species may be established.

PLATE XCI.

Fig. 1 *a*, *b*. The cast of a small individual.

Fig. 2 *a*. Ventral view of a larger individual, with a small muscular impression.

Fig. 2 *b*, *c*. Cardinal and dorsal views of the preceding, showing the cavities made by the brachial lamellæ and cardinal process, and the impression of the longitudinal crest.

Fig. 3. The ventral side of a cast with narrow and small muscular impressions (perhaps a distinct species).

Fig. 3 *a*. The cast of a specimen preserving a large and strongly marked muscular impression.

Fig. 3 *b*. A mould from the cast shown in the preceding figure. (The imprints of the adductor muscles are omitted in the drawing.)

Fig. 3 *c*, *d*, *e*. Dorsal, profile and cardinal views of the same specimen.

PLATE XCV.

Fig. 1. Dorsal view of a specimen preserving the shell. The striæ are partially obliterated by the silicification of the shell, and they are not sufficiently curved towards the hinge-line in the figure.

Fig. 2. Profile view of the same specimen.

Fig. 3 & 4. Dorsal and ventral views of a smaller specimen.

Fig. 5. Interior of the ventral valve.

Fig. 6. Interior of the dorsal valve.

Fig. 7. Cardinal view of the dorsal valve, showing the outline and the elevation of the processes. The characters shown in these figures are quite sufficient to distinguish this species from any known in the rocks of this age or elsewhere.

Geological position and locality. In the Oriskany sandstone : Albany and Schoharie counties (New-York), Cumberland (Maryland), and other places.

Strophodonta magniventra.

PLATE XCII. FIG. 2 *a b c*, & 3; and PLATE XCV. FIG. 9.

Strophodonta magniventra : HALL, Regents' Report, 1857, p. 54; Palæozoic Fossils, p. 14.

SHELL subsemicircular, varying to longitudinally suboval; length usually two-thirds the breadth, sometimes equal or greater. Ventral valve convex in the central and umbonial regions, flattened towards the extremities : beak slightly incurved; cardinal border sloping from the umbo; hinge-line crenulated, equal to or greater than the greatest width of the shell, sometimes extended into mucronate points beyond the lateral margins. Area of ventral valve broad, slightly curved, distinctly marked by vertical striæ produced by the prolongations of the hinge: foramen closed.

SURFACE marked by regular, rounded, slightly elevated, radiating striæ : interior scarcely granulose, having a plicated flabelliform muscular impression, covering nearly two-thirds of its extent, and varying somewhat in its form and proportions. The adductor muscles occupy a narrow elongated oval space.

The area sometimes shows a flat triangular space indicating the foramen, but I have no evidence that it is ever free. In a single separate valve, there is a strong central process underlying the area in the centre, with a cavity on each side for the reception of the bifurcate cardinal process of the other valve.

Dorsal valve [of this species?] deeply concave, radiatingly striated; the striæ finer than those on the ventral valve. The interior of the valve is marked by well-defined muscular areas; and outside of these, the vascular and ovarian spaces occupy a large part of the shell, having a well-defined semielliptical area of a width little greater than the length, and somewhat contracted at the cardinal angles. The margin outside of the vascular area is striato-punctate.

This species has been determined from the strongly marked casts of the ventral valve, its usual mode of occurrence in the Oriskany sandstone. I have a single ven-

tral valve of the same species from Cumberland (Maryland). The impression of the dorsal valve, which, from its corresponding cavity and other characters, I have regarded as of the same species, is very distinctly marked in its reniform muscular impressions and the slight divergence of the vascular impressions in the lower part of the area.

PLATE XCII.

Fig. 2 *a*. The cast of the interior of a ventral valve, where the muscular impression is very strongly marked and occupies a large part of the area of the valve. The central upper portion, marked by the adductor muscles, is, in this and some other specimens, well defined and separated from the other parts.

Fig. 2 *b*. A similar cast, where the cardinal angles are more extended and the muscular impressions less strongly defined. Both this and the preceding specimen show the imprint of the strongly striated cardinal area; the first one having a flattened space without striæ in the place of the foramen, while this feature is less distinctly seen in the latter.

Fig. 2 *c*. A fragment of a similar specimen, showing a process extending into the cavity towards the beak of the valve. A mould made from the casts of this species shows the foramen to be entirely closed, with a thickened process below and a cavity extending beneath it towards the beak; as if there may have been, at some period of growth, a perforation of the apex.

Fig. 3. The exterior of the ventral valve, showing the strongly striated surface.

PLATE XCV.

Fig. 9. This figure is an impression taken from a mould in sandstone, left by the solution and removal of the shell. In several specimens of this kind, in different stages of growth, the internal markings are precisely similar. The broad reniform muscular impressions are strongly defined by an elevated rim; and between these and the median crest there are, on each side, other equally marked impressions, which, with the flattened median crest, appear to have been the points of attachment for the adductor muscles. Below and outside of these are vascular impressions approaching those of PRODUCTUS, which are strongly marked, but not limited as the others.

The direction of the vascular impressions towards the basal and lateral margins of the area is very direct, and the ramifications but slightly divergent; a character to be noticed in comparison with other species.

Geological position and locality. In the Oriskany sandstone : Albany and Schoharie counties (New-York), and Cumberland (Maryland).

Strophodonta vascularia (n. s.).

PLATE XCII. FIG. 4; and PLATE XCV. FIG. 10 : also PLATE XCIII. FIG. 2 *b* & *c*?

SHELL semielliptical, convex : cardinal extremities rounded. Ventral valve, in the cast, showing a narrow crenulated area : muscular impressions large, flabelliform, the adductor muscles occupying an oval space. The larger flabelliform area has the divisions ramifying and diverging below, the narrow lines being the elevated parts and the

broader ones the depressed portions (in this respect the reverse of the preceding species). Surface of the cast striato-punctate.

The dorsal valve (which I have inferred may belong to the same species) is gently concave in the middle, and more abruptly bent outwards towards the margin. The double cardinal process is strongly developed. A cast from the mould in sandstone shows a large area, marked by the internal vessels. The areas for the attachment of the cardinal and adductor muscles are narrow and elongated; while below, and directed outwards, is a curving line, marking a space similar to the vascular impressions of the dorsal valve of *Productus* (these lines are not properly shown in the figure). The ovarian spaces are strongly corrugated, and the lower part of the area is marked by elevated ramifying and diverging lines, while the margin outside of this limit is simply striato-punctate.

This species, in the dorsal valve, differs from the preceding in the narrower muscular impressions, and a more strongly marked curving line from the base of the cardinal muscles, while the space it encloses is less prominent : the ramifying muscular impressions in the lower part of the area are more prominent and more divergent. I have not seen the valves in connexion, nor any other portions of the fossil except the impressions left in the sandstone.

The differences indicated in the casts seem to me sufficient to warrant the separation of these forms; the latter one, indeed, showing in its dorsal valve more affinity with the following than with the preceding species.

PLATE XCII.

Fig. 4. A cast of the ventral valve. (The muscular and vascular markings are not correctly represented in the figure.)

PLATE XCV.

Fig. 10. A cast of the dorsal valve from an impression in sandstone. The divisions of the cardinal process are not of the full length, owing to the cavities not becoming filled with the material forming the cast. The principal differences described are shown in the figures of the dorsal valves of the two species.

The figures 2 *b* and 2 *c*, Plate XCIII, are referred to this species with some hesitation : they are the impressions of the exterior of the dorsal valve, and show the convexity corresponding to the concavity of the shell, which only occur in an equal degree in this or the preceding species; the others known in the rock being much less concave on the dorsal valve.

Geological position and locality. In the Oriskany sandstone : Helderberg mountains, Albany county.

Strophodonta magnifica.

PLATE XCIII. FIG. 4; PLATE XCIV. FIG. 2 *a – d*; and PLATE XCV. FIG. 8.

Strophodonta magnifica : HALL, Regents' Report, 1857, p. 54; Palæozoic Fossils, 1857, p. 14.

SHELL very large, transversely suboval longitudinally, somewhat semi-elliptical, more or less rounded at the extremities of the hinge; length and breadth about as four to five, or as seven to eight. Ventral valve depressed-convex in the middle and umbonial regions, flattened near the lateral extremities : cardinal margin sloping gently from the beak. Dorsal valve slightly concave, sometimes flat in the middle : hinge-line crenulated, usually a little less than the width of the shell, sometimes greater. Area narrow, distinctly and regularly marked with transverse striæ produced by the prolongations of the hinge crenulations; foramen sometimes a linear slit.

SURFACE marked by somewhat faint radiating striæ, which bifurcate regularly about two or three times at uniform distances from the beak.

The interior of the ventral valve is marked by a large flabelliform muscular impression, the sides of which are straight and bordered by an elevated ridge or crest, while the divisions are sharply defined : the whole gradually becomes obsolete on the anterior or basal margin. The thickened process beneath the area in the centre is usually perforated by a round or oval foramen, leaving a narrow slit in place of the triangular opening.

The interior of the dorsal valve of this species, as shown by the impressions in sandstone, and in a single imperfect valve, shows a broad vascular area, which is defined by a low flattened ridge, or sometimes a more distinctly marked border, on the outside of which the shell is more abruptly curved. The impressions of the cardinal muscles are narrow subreniform, and in proportion are wider than those of *S. vascularia*, while they are narrower than those of *S. magniventra*. In well-preserved specimens there is a defined subreniform vascular area below the cardinal muscular impressions on each side, and a similarly marked space, a little

more faintly defined, extending downwards and terminating in a lanceolate point. The ovarian spaces are corrugated or pustulose, and the lower part of the vascular area is striato-punctate or striato-pustulose; the impressions of the external striæ appearing more conspicuously than in either of the preceding species, while the impressions of the ramifying vessels are usually but faintly marked or not at all shown.

This species is remarkable for the large size to which it sometimes attains. One of the individuals figured has a width of four, with a length of a little more than three and a half inches; while the other has a width of a little more than three and a half, with a length of three inches, being perhaps the largest brachiopod known in the rocks of this State.

PLATE XCIII.

Fig. 4. The cast of a ventral valve, preserving the marks of the muscular impression and the imprints of the radiating striæ.

PLATE XCV.

Fig. 8. A cast of the ventral valve, showing the muscular impression in part, with the shell preserved upon the lower part of the specimen.

PLATE XCIV.

Fig. 2 *a*. The impression of the dorsal valve of this species in sandstone. The cavities of the cardinal process are not shown in the figure.

Fig. 2 *b*. A cast taken from a similar mould, showing the diverging divisions of the cardinal process, crenulated hinge-line, muscular impressions, etc. (The details of the marking are not well shown in this figure.)

Fig. 2 *c*, *d*. The impressions of the same in sandstone, the marking being preserved in different degrees of perfection in the two specimens.

Geological position and localities. In the Oriskany sandstone : Albany and Schoharie counties (New-York), and Cumberland (Maryland).

Strophodonta lincklæni.

PLATE XCIII. FIG. 2 & 3 *a*, *b*.

Strophodonta lincklæni : HALL, Regents' Report, 1857, p. 55; Palæozoic Fossils, 1857, p. 15.

SHELL semielliptical, more than three-fourths as long as broad; lateral margins usually contracted below the extremities of the hinge-line, which is crenulated, equalling or exceeding the greatest width of the shell below. Dorsal valve concave, deflected around the front and sides.

SURFACE marked by fine closely arranged radiating striæ, which are crossed by obscure concentric lines of growth. Interior surface granulose, and more or less striate.

The ventral valve has not been positively identified in its external or internal characters. The interior of the dorsal valve is gently concave over the greater part of its area, and, towards the margin, is suddenly bent upwards or outwards, the line of bending being distinctly defined at about a quarter of an inch from the margin in front, in shells of ordinary size; the distance at the sides, and towards the cardinal angles, being somewhat less.

The cardinal process is bifid at the extremity uniting in one below; being continued laterally in an oblique and gradually curving direction, limiting the cardinal muscular impression by a low crest, and continued from the centre in a more prominent median ridge to the commencement of the adductor muscles, or about one-fourth the entire length of the shell, where it is flattened, and rises again below this point The imprints of the cardinal and adductor muscles are not strongly defined, though the places of the latter are indicated in their outer limits by a low ridge on each side parallel to the median one.

The entire interior of the shell is finely punctate or striato-punctate.

The specimens, which can be referred with certainty to this species, are impressions of the exterior of the dorsal valve, and impressions of the interior of the same valve. It is distinguished from the other species by its comparatively more elongate form. The interior is marked by a more slender cardinal process and fainter median lines, while the muscular and vascular impressions are much less strongly defined.

In the absence of well-determined exterior characters, and of the interior of the ventral valve, we may rely on the interior of the dorsal for characterizing the species.

Fig. 2 *a* (the specimen referred with doubt to this species). The exterior of a ventral valve, in which the shell is partially exfoliated.

Fig. 3 *a*. The imprint made by the interior of the dorsal valve of a small individual, showing the cavities made by the bifurcating cardinal process, the impressions of the median crest, and the low ridges towards the centre of the shell.

Fig. 3 *b*. The impression of a larger ventral valve of this species, showing the same features as the preceding, the crenulated hinge-line, and the abruptly recurved outer margin.

Geological position and locality. In the Oriskany sandstone : Albany and Schoharie counties.

Strophomena rugosa, var. ventricosa.

PLATE XCIV. FIG. 2 *e*, *f*, & 3.

Strophomena depressa, var. *ventricosa* : HALL, Regents' Report for 1856, p. 55; Pal. Foss. 1857, p. 15.

SHELL transversely oblong, somewhat semioval; length and breadth sometimes nearly equal; front often straight in the middle : hinge-line equal to the greatest width of the shell. Ventral valve extremely ventricose, scarcely geniculate in front. Dorsal valve forming an inclined plane from the hinge towards the front, near which it is abruptly deflected, giving the valve a deep concavity; area sublinear, longitudinally striate : interior distinctly granulose; muscular attachments strongly marked; lateral margins contracted, so as to leave small auricular extensions at the cardinal angles.

Internal casts, with fragments of separate valves of this shell have been seen : its general aspect is like that of *Strophomena rugosa*, though its internal muscular attachments often deviate considerably from those of well-marked specimens of that species. The ventral valve is also more regularly arched and gibbous in outline than is usual in *S. rugosa* ; and it has not the abrupt geniculation in front, so characteristic of that shell.

The casts of the interior of the ventral valve are almost regularly ventricose, a little more abruptly bent in front; the muscular impressions are well marked, and deeply divided longitudinally in the middle; the median ridge being broad at the base, with a narrow thin crest, as shown both in the casts and in the interior of the valves. The dental lamellæ are produced in a thin elevated crest which surrounds the muscular area, except a narrow space at the base.

In the casts of the dorsal valve, the muscular imprints are strongly marked with two large pits for the double cardinal process. The casts taken from these impressions preserve the same general features as those of the *S. rugosa* from the limestones of the Lower Helderberg group, but are more elongated, and more strongly defined in the elevation of the parts above the general surface of the interior of the shell. The interior of this valve, moreover, does not present the marked elevation which limits the vascular area, or that portion just within the geniculation of the shell.

A single dorsal valve of this form has a length of one inch and three-fourths, with a width of two inches.

Fig. 2 *e*. A cast taken from the impression of a dorsal valve in sandstone.

Fig. 2 *f*. An impression of the dorsal valve in sandstone.

Fig. 3. A cast in sandstone of the ventral valve. The specimen has been weathered, and the parts are not as salient as they otherwise would be. The hinge-line is obliterated in the specimen.

Other specimens of the casts, and the separate valves of the species, more recently obtained, have served to illustrate more fully the characters here represented but imperfectly.

Geological position and localities. In the Oriskany sandstone : Albany and Schoharie counties (New-York), and Cumberland (Maryland).

Chonetes complanata.

PLATE XCIII. FIG. 1 *a*, *b*, *c*, *d*.

Chonetes complanata : HALL, Regents' Report for 1856, p. 54; Palæozoic Fossils, 1857, p. 14.

SHELL transverse, longitudinally semielliptical, about two-thirds as long as wide. Ventral valve flat or concave. Dorsal valve unknown : tubular spines of the cardinal margin directed obliquely outwards.

SURFACE marked by fine closely arranged bifurcating striæ, which appear to have been crenulated by closely arranged concentric striæ. Some of the specimens show distant imbricating concentric lines of growth : interior striato-granulose; muscular impression large, not strongly marked.

All the specimens seen of this rare species consist of internal and external casts of the ventral valve, from which it is impossible to make out a complete description. The few remaining impressions of the row of tubular spines along the cardinal margin are barely sufficient to show the presence of these appendages, and do not clearly indicate their number, length, curvature, etc. It may be recognized by its extreme flatness, finely striated surface, a few distant laminæ of growth, and great proportional width.

Fig. 1 *a*. An impression of the outside of the ventral valve of this species.

Fig. 1 *b*. A similar impression in sandstone, showing the concentric lines of growth.

Fig. 1 *c*. A cast of the interior of a ventral valve, showing the muscular impression and cavities of the dental lamellæ.

Fig. 2 *e* (in centre of plate, by error for 1 *d*). An enlargement of the imprint of the surface, as sometimes seen in sandstone.

Geological position and locality. In the Oriskany sandstone : Albany and Schoharie counties.

Leptæna? nucleata.

PLATE XCIV. FIG. 1 *a*, *b*, *c*, *d*.

Leptæna nucleata : HALL, Regents' Report of 1856, p. 47; Palæozoic Fossils, 1857, p. 7.

SHELL semicircular. Ventral valve extremely gibbous, abruptly depressed or flattened towards the lateral extremities : beak (internal cast) very abruptly incurved, and divided by a central groove which extends downwards nearly to the middle of the valve. Dorsal valve unknown : hinge-line equal to the greatest width of the shell, terminating in minute triangular extensions; area sublinear, incurved beyond the plane of the valves. Surface unknown.

Internal casts of the ventral valve of this little shell are common in the Oriskany sandstone; but I have seen no specimens showing the external characters, nor have any specimens of the dorsal valve yet been recognized. I have referred it provisionally to the Genus LEPTÆNA, but with much doubt as to its true generic relations.

Fig. 1 *a*, *b*. Ventral and profile views of the cast.
Fig. 1 *c*. Cardinal view.
Fig. 1 *d*. Profile view enlarged.

Geological position and locality. In the Oriskany sandstone : Albany county.

Spirifer submucronatus.

PLATE XCVI. FIG. 7 *a*–*f*.

Spirifer submucronatus : HALL, Regents' Report of 1856, p. 62; Palæozoic Fossils, 1857, p. 22.

SHELL semicircular, with the extremities mucronate : valves equally and moderately convex. Ventral valve regularly convex, a little flattened at the lateral extremities : beak little elevated above the area line, and slightly incurved; mesial sinus shallow, and flat in the middle; area of moderate height; foramen somewhat large, often partially closed. Dorsal valve depresso-convex in the middle and flattened laterally, often a little concave towards the extremities : mesial fold distinctly defined, equal in width to the two adjoining costæ, somewhat

flattened in the centre : beak little elevated above the hinge-line, and scarcely incurved.

SURFACE marked by ten to fourteen simple rounded and moderately elevated costæ; concentrically marked by delicate imbricating lamellæ, which are usually almost obsolete or obliterated when the shell is silicified, leaving smooth rounded plications.

This species resembles in general form the *S. cumberlandiæ*, but is a smaller and more delicate shell, with a smoother surface and fewer plications, the space of four on the margin of that species covering six or seven on this one. The muscular impression of the ventral valve is proportionally smaller and less distinctly striated, while the median septum is scarcely developed below the cavity of the beak.

Fig. 7 *a*, *b*. Ventral and dorsal views of a specimen of this species.
Fig. 7 *c*. A specimen with one of the cardinal angles more extended.
Fig. 7 *d*. Front view of the preceding.
Fig. 7 *e*. Profile view of a specimen of this species.
Fig. 7 *f*. The interior of the ventral valve.

Geological position and locality. In the Oriskany sandstone : Cumberland, Md.

Spirifer tribulis (n. s.).

PLATE XCVI. FIG. 8 *a* – *e*.

SHELL transverse, varying from semicircular to semielliptical; cardinal extremities more or less rounded, gibbous in the middle. Ventral valve more convex than the dorsal : beak elevated and incurved; sinus narrow and shallow above, becoming deeper and subangular below; area variable, usually of moderate height, the exterior margins sometimes strictly defined. Dorsal valve very convex towards the umbo : beak incurved, and often elevated above the hinge-line; a narrow area.

SURFACE marked by from four to six or seven plications on each side of the mesial fold and sinus : plications elevated, abruptly rounded, the depressions subangular towards the margin; concentrically marked by fine lamellose imbricating striæ and finer radiating striæ, which cover the entire shell.

The interior of the ventral valve shows strong dental lamellæ, which are curved backwards beneath the area, and do not extend so low on the shell as its lower margin. Muscular area not defined in the specimen examined.

This species resembles the *S. cycloptera* of the Lower Helderberg group; and it may be only a variety of form, resulting from a change of conditions in the sediment. The proportions are usually somewhat different, and the area is higher than in that species.

Fig. 8 *a*, *b*. Ventral and dorsal views of a specimen of ordinary size.
Fig. 8 *c*. Front view of a specimen which is less gibbous than usual.
Fig. 8 *d*. Profile view of a more gibbous specimen. (The dorsal valve is represented as too convex.)
Fig. 8 *e*. An enlargement of the surface, showing the fine concentric and radiating striæ.

Geological position and locality. In the Oriskany sandstone : Cumberland, Md.

Spirifer cumberlandiæ.

PLATE XCVI. FIG. 9 *a* – *g*.

Spirifer cumberlandiæ : HALL, Regents' Report of 1856, p. 63; Palæozoic Fossils, 1857, p. 23.

SHELL broadly semicircular; valves moderately and nearly equally convex. Ventral valve regularly convex; mesial sinus narrow, shallow, and flat in the middle : beak gently incurved, and projecting slightly beyond the hinge-line; area broad, nearly flat, parallel with the axis of the shell; foramen somewhat large, often partially or entirely closed. Dorsal valve having a narrow flattened mesial fold, convex in the middle, and flattened towards the extremities : beak scarcely incurved, and nearly in the same plane with the cardinal margin; hinge-line straight; extremities extended.

SURFACE marked by fourteen to seventeen simple rounded costæ, which are crossed by concentric elevated lines or lamellæ.

The muscular impressions in the ventral valve are well defined and distinctly striated longitudinally, with a broad median ridge, which, in its upper part, is marked by a narrow central crest. The dental lamellæ

are very strong, but scarcely extended below the limits of the area. The cardinal process in the dorsal valve is not so high as the area, but the crural processes are very strong and prominent, with deep fossets for the reception of the teeth of the opposite valve.

In general form this shell resembles *S. mucronatus*, but is conspicuously distinct in its wider area : it is usually broader, with the mesial sinus and elevation narrower than in that shell. The mesial elevation on the dorsal valve is often flattened, but sometimes rounded. The concentric lamellose striæ are sometimes but faintly developed, or have become obsolete from weathering or the process of silicification.

Fig. 9 *a*, *b*. Dorsal and ventral views of a large individual, showing the foramen almost entirely closed.

Fig. 9 *c*. Profile of the base or front of the shell.

Fig. 9 *d*. Lateral profile view.

Fig. 9 *e*. Ventral view of a specimen from the upper part of which the shell is removed, showing the cast of the muscular area and the rostral cavity.

Fig. 9 *f*. Interior of the dorsal valve, showing the cardinal and crural processes, with the dental fossets.

Fig. 9 *g*. Interior of the ventral valve, showing the partial closing of the foramen, with a perforation at the summit, the dental lamellæ, etc.

Geological position and locality. In the Oriskany sandstone : Cumberland, Md.

Spirifer arrectus (n. s.).

PLATE XCVII. FIG. 1 *a* – *h*, & 2 *a* – *i*.

SHELL transverse, varying from semicircular to semielliptical; cardinal angles sometimes rounded, but often produced beyond the width of the shell below. Ventral valve more or less gibbous than the opposite: beak elevated and incurved; the area above the medium height, more or less concave, extending to the hinge extremities, separated from the exterior shell by a sharply defined margin; foramen large; sinus varying from a depression of moderate depth with curving sides and base, to a deep angular depression which elevates the mesial portion of the opposite valve in an angular fold. Dorsal valve often very convex in the middle and towards the front; the mesial fold often abruptly elevated, and varying from a rounded to a sharply angular prominence; the beak incurved beyond the hinge-line.

Surface marked by from five to seven or eight plications on each side of the mesial fold and sinus, which are either round or subangular and more or less elevated. The entire surface is ornamented by fine closely arranged concentric striæ; and these are again crossed by finer radiating striæ, which are more prominent on the edges of the lamellæ, giving to the perfect shell a granulose exterior.

The casts of the ventral valve, which are abundant in the sandstone, show a large prominent process which is strongly defined by the impressions of the dental lamellæ : this process, which indicates the form and dimensions of the muscular area, is variously striated, sometimes with a few strong ridges, and in others with finer longitudinal striæ, and more rarely the curving transverse striæ are preserved. The cast is strongly papillose on each side of the muscular area. The cast of the dorsal valve shows a sharp median line down the fold, indicating the interior median ridge.

This shell is very variable in its original form and proportions, and in the greater or less angularity of the plications. The finer surface markings are rarely preserved in the sandstone, and the fossil is found in various degrees of exfoliation, from specimens preserving the greater part of the shell, to those which are complete casts of the interior. It has likewise suffered more or less from distortion, so that it appears under various aspects, and might be mistaken in its different phases for more than a single species.

This fossil has been referred by M. de Verneuil to the *Spirifer macropterus* of Roemer*, to the casts of which it bears some resemblance. In our shell the hinge is never so extended, nor the plications so numerous; the area is wider, and never so linear as in the European species; and though in its numerous variations the casts of our species offer some analogy with the figure of Dr. Roemer, the muscular impression is always more prominent, showing originally a more elevated beak. While no specimen of the shell observed offers a very great similarity to the figure 4 of the plate referred to, a specimen of our species, of the same extent of hinge-line, would present a beak of more than a quarter of an inch above the line of the dorsal valve.

The Oriskany species bears a considerable similarity to some forms of *Spirifer* brought from the Falkland islands by Mr. Darwin, and described by Messrs. Morris

* C. F. Roemer : Das Rheinische Uebergangsgebirge, pag. 71, tab. 1, f. 3 & 4.

and SHARPE in the Quarterly Journal of the Geological Society of London, Vol. ii, pa. 276, pl. 41; but the general features here shown are apparently common to many Spiriferæ of the Higher Silurian or Lower Devonian beds.

Fig. 1 *a*, *b*. Dorsal and front views of a specimen in which the shell is partially exfoliated. (The mesial fold is more angular in the specimen than is represented in the figure.)

Fig. 1 *c*. The ventral valve of another specimen, in which the plications are rounded.

Fig. 1 *e*. A ventral valve which is more extended on the hinge-line, and preserves to a considerable degree the surface markings, and has about eight plications on each side.

Fig. 1 *f*. A ventral valve of proportionally greater length : the plications are broad and rounded, and seven are visible on each side.

Fig. 1 *g*. Profile view of a gibbous specimen.

Fig. 1 *h*. An enlargement of the surface, showing the fine concentric and radiating striæ as they appear on a worn surface.

Fig. 2 *a*. The dorsal side of a cast, in which the plications are sharply angular.

Fig. 2 *b*, *c*, *d*, *e*. Casts of the ventral valve, showing a variety of form and markings in the cast of the muscular impression, and in the number and development of the plications.

Fig. 2 *f*. Cardinal view of a cast which is somewhat distorted, and shows a part of the ventral valve : the beak is broken off.

Fig. 2 *g*. A cardinal view of the cast of a ventral valve, showing the elevation of the process filling the beak.

Fig. 2 *h*. A similar view, showing also the ventral side and the median line.

Fig. 2 *i*. The cast of a distorted specimen.

Geological position and localities. In the Oriskany sandstone, everywhere in the State of New-York, and at Cumberland (Maryland).

Spirifer intermedius (n. s.).

SHELL transverse, semielliptical; the ventral valve moderately and regularly convex, area of medium height, foramen large; mesial sinus of moderate depth, rounded. Dorsal valve unknown.

SURFACE (of a specimen one and a half inches wide) marked by ten depressed plications on each side of the mesial sinus.

The dental lamellæ are not at all or but slightly thickened : the muscular impression is broad and strongly striated, with sometimes a filling of the cavity of the beak.

This species has been recognized in a few imperfect specimens of the ventral valve; but its regular convexity, more numerous rounded and little elevated plications, with a somewhat shallow sinus, distinguish it at once from the *S. arrectus* with which it is associated.

Geological position and locality. In the Oriskany sandstone : Cumberland, Md.

Spirifer arenosus.

PLATE XCVIII. FIG. 1 – 8; PLATE XCIX. FIG. 1 – 10; and PLATE C. FIG. 1 – 8.

Delthyris arenosa : CONRAD, Annual Report on the Palæontology of New-York, 1839, p. 65.
D. — VANUXEM, Report on the Third Geological District, 1843, p. 123, f. 1.
D. — MATHER, Report on the First Geological District, 1843, p. 342, f. 1.
D — HALL, Report on the Fourth Geological District, 1843, p. 148, f. 1.

SHELL, in the young state, semielliptical, with the beak a little elevated above the hinge-line; the old shell becoming ventricose, and the beak much elevated above the hinge-line, having a somewhat semioval form. The proportions vary from length and width equal, to width one-third greater than the length. Cardinal angles sometimes produced in acute terminations, but usually rounded, particularly in old shells.

VENTRAL valve very regularly convex, the greatest convexity about one-third the distance below the beak. The cardinal angles, when produced, are a little flattened. The mesial sinus is very shallow, being often little more than a flattening of the surface along that part of the shell. The umbo is broad, and the beak a little incurved over the area. Area in young shells narrow, and in old shells proportionally wider, and extending to the cardinal extremities : the foramen is wide, and, in old shells, partially closed above. The dental lamellæ are strong; the extremities, rising above the cardinal line and bending backwards beneath the area, are widely divergent as they extend from the beak downwards. The muscular impressions are large, and very strongly and beautifully marked.

DORSAL valve of the same form as the ventral; its greatest convexity in the middle, with a very narrow cardinal area, above which the beak is slightly incurved. Mesial elevation very moderate, and sometimes scarcely defined.

SURFACE marked by regular simple rounded or sometimes subangular plications, of which there are from ten to twenty on each side of the mesial fold and sinus. The mesial sinus is simple at the apex; but a

plication becomes developed in the bottom of it, and each of the bordering plications is dichotomized; the central one dichotomizing once, and in old shells twice, before reaching the margin. Very young shells show a sinus with a simple plication in the bottom. The mesial elevation of the dorsal valve is simple in very young shells, showing first a central groove, then each marginal plication becomes dichotomized, and at the same time a central plication rises in the median groove; and the mesial fold, at its base, consists of five distinct plications, the result of the dichotomizing of a single one at the apex. Surface marked by fine concentric striæ and stronger imbricating lines of growth.

In the casts of the interior, this fossil presents considerable variety of appearance, owing to the variable extent of the muscular area, the development of its markings, and depth of the cavity beneath the beak; characters due in part to the different ages of the shell, but often apparently to other causes.

This is a beautiful and interesting species of *Spirifer*, being the first one in the order of time, so far as known, in our rocks, which shows the dichotomizing of the plications; and this feature extends only to the mesial sinus and elevation.

In the Oriskany sandstone in New-York the shell is rarely well preserved, being more or less exfoliated in separating from the matrix, or occurring in the condition of casts, of which great numbers are found in the rock.

The specimens figured on Plates XCVIII and XCIX are all from the sandstone in New-York; while those on Plate C are from the Oriskany sandstone in Maryland, and were obtained only long after the other plates were completed. These are so well preserved, and show the characters so perfectly, that they form a necessary part of the illustration of the species.

PLATE XCVIII.

Fig. 1 & 2. Two views from the same specimen, which is slightly distorted and the shell partially removed.

Fig. 3. Ventral valve of a large specimen.

Fig. 4. A dorsal view, showing the area and foramen.

Fig. 5. View of a ventral valve.

Fig. 6. The dorsal side of a specimen where the shell is worn from the mesial fold, partially from the sides of the valve.

Fig. 6 *a*, *b*. Front and profile views of the same specimen, the ventral side being a cast the interior.

Fig. 7. The interior of a large ventral valve.

Fig. 8. Enlargement of the plications, showing fine concentric striæ.

PLATE XCIX.

Fig. 1, 2 & 3. Casts of the dorsal valve of young and medium-sized specimens.

Fig. 4 & 5. Casts of larger individuals, showing the marks of the muscular impressions. In the smaller specimens the arching striæ are rarely well shown in the cast of the muscular impressions, while the longitudinal ones are well shown.

Fig. 6 *a*. A specimen below the medium size, in which the marks of the muscular impression are well preserved, the transverse striæ being as distinct as in older shells.

Fig. 6 *b*. Cardinal view of the same specimen.

Fig. 7 & 8. Casts of the ventral valve of very old specimens.

Fig. 9 & 10. Casts of the dorsal valve, the latter figure presenting an unusual extension of the beak.

PLATE C.

Fig. 1 *a*, *b*. Dorsal and ventral views of a very young specimen, showing the characters already described.

Fig. 2. A larger specimen.

Fig. 3 *a*, *b*. Dorsal and ventral views of a larger specimen, showing the commencement of the dichotomizing of the plications of the mesial fold and sinus.

Fig. 4 *a*, *b*. Dorsal and ventral views of a specimen of medium size, in which the cardinal angles are a little produced.

Fig. 4 *c*. Profile view of the same specimen.

Fig. 4 *d*. Cardinal view of the same.

Fig. 4 *e*. Front view of the same.

Fig. 5. The interior of a dorsal valve.

Fig. 6. The interior of a ventral valve, with an area of medium width, and a slight thickening on each side of the muscular impression.

Fig. 7. An old shell having the foramen partially closed by a callosity, and an excessive thickening of the shell on the inside. The inner laminæ of the shell are much broken away.

Fig. 8 *a*. The exterior of the ventral valve of a large individual, which preserves the external markings in a good degree of perfection.

Fig. 8 *b*. The interior of the same, showing the large area, partially closed foramen, and dental lamellæ, while the inner lamina of the shell around the muscular impression is exfoliated.

There are certain variations of form noticed among the individuals in large collections of this fossil, which indicate a variety, or possibly a specific difference.

Geological position and locality. Everywhere in the Oriskany sandstone in New-York; being one of the most constant, if not the most persistent fossil of the rock. In the same rock in Maryland, Virginia, and elsewhere.

Spirifer pyxidatus (n. s.).

PLATE C. FIG. 9 – 12.

SHELL semielliptical in outline, one side angularly gibbous in the middle; cardinal line equalling (sometimes a little greater or less than) the greatest width of the shell. Ventral valve with a narrow mesial sinus, in the summit of a broad strong elevation; the beak abruptly incurved over a narrow linear area, which extends to the cardinal extremities; foramen of moderate width, with strong divergent dental lamellæ. The muscular impressions are well marked, and sometimes there is a thickened process from the interior filling the summit of the foramen. Dorsal valve flat at the sides and near the beak, with a broad depression below, in the centre of which is a narrow mesial elevation. The margins of the shell on each side present a few undulations or marginal folds, and, in rare examples, these reach half way to the beak.

The surface, in its perfect condition, has been concentrically striated, with finer longitudinal striæ.

This small species occurs in the Oriskany sandstone of New-York, in the condition of casts, and, from its small size and peculiar form, had not been very satisfactorily determined. Some specimens of the shell from Cumberland (Maryland) preserve the characters showing the structure of a true *Spirifer*; while the exterior, in its general expression, departs from the ordinary forms of this genus.

Fig. 9 *a*. Dorsal view of a specimen of this species.
Fig. 9 *b*. Ventral view of the same.
Fig. 9 *c*, *d*. Profile and front views of the same.
Fig. 10. The interior of the ventral valve, showing the area, etc.
Fig. 11. The cast of the ventral valve.
Fig. 12. A cast of the dorsal valve.

Geological position and localities. In the Oriskany sandstone : Albany and Schoharie counties (New-York), and Cumberland (Maryland).

Cyrtia rostrata.

PLATE XCVI. FIG. 1 – 6; and PLATE XCVIII. FIG. 8 *a*, *b*.

Cyrtia rostrata : HALL, Regents' Report for 1856, p. 64; Palæozoic Fossils, 1857, p. 24.

SHELL triangularly pyramidal, more or less elevated : hinge-line straight, equalling or greater than the greatest width of the shell below, and sometimes extending into acute angles. Ventral valve much elevated at the beak, a distinct sinus extending from beak to front : beak simple, angular, not incurved. Dorsal valve convex, semicircular; mesial fold moderately elevated, rounded or slightly flattened, and marked with a faint longitudinal depressed line : beak scarcely elevated above the cardinal margin : area broad triangular, plane, or rarely subarcuate; foramen narrow, extending to the apex of the beak of the ventral valve, partly closed above by a central plate.

SURFACE marked by five to eight or nine elevated subangular costæ on each side of the middle, concentrically marked by imbricating lamellæ and finer striæ, which are crossed by fine radiating striæ; the entire surface, in perfect specimens, being papillose.

The interior of the dorsal valve shows two strong crural processes with the dental fossets, and a cardinal process which is more or less developed. In the ventral valve, the dental lamellæ, uniting at their bases, are continued in a median septum, which is extended nearly to the anterior margin of the shell : the same septum, extending into the triangular cavity of the foramen, approaches to the plane of the area, which, in well-preserved specimens, is distinctly striated vertically. A single specimen preserves the internal spires.

This species bears some resemblance to *Cyrtia* (*Spirifer*) *heteroclita;* but it has a greater number of plications, and is a larger and coarser shell.

The youngest specimen observed of this species has six plications on each side of the mesial fold, while the older ones have eight or nine : the plications vary from angular to round.

In the sandstone of New-York the species is very rare, a single cast only having been seen in all the collections made.

PLATE XCVI.

Fig. 1 *a*, *b*. Dorsal and cardinal views of a young specimen, which has six plications on each side of the mesial fold.

Fig. 2 *a*, *b*. Dorsal and front views of a larger specimen.

Fig. 2 *c*, *d*. Profile and cardinal views of the same specimen.

Fig. 3 *a*, *b*. Cardinal and front views of another individual, with a higher area and less extended hinge-line. The beak in fig. 3 *a*, as represented, is not sufficiently elevated.

Fig. 4 *a*. Ventral valve of an old specimen.

Fig. 4 *b*. Dorsal valve of the same.

Fig. 4 *c*, *d*. Profile and cardinal views of the same specimen.

Fig. 5. Interior of the dorsal valve.

Fig. 6 *a*, *b*. The exterior and interior of a dorsal valve of this species.

PLATE XCVIII.

Fig. 8 *a*, *b*. Ventral and cardinal view of an imperfect cast of this species.

Geological position and locality. In the Oriskany sandstone : Albany county (New-York), and Cumberland (Maryland).

The preceding species of *Cyrtia* is presented in so many varieties of form, and with such a degree of variation in the number of plications, that I had regarded the specimens figured as of two distinct species. A farther examination, however, with a larger number of specimens before me, has convinced me that these are all varieties of a single species.

There is yet room for inquiry in regard to the degree of variation assumed by *Spirifer arrectus*, or whether some of the forms occurring with this one are really varieties of it; or whether they may be a distinc species more nearly related to S. *cyclopterus*, or perhaps a variety of th latter species, which, in the sandstone, attains a larger size than in t shaly limestone below.

The *Spirifer intermedius* has not been seen in specimens sufficie well-preserved, to admit of the full determination of its more mi characters.

Merista lata (n. s.).

PLATE CI. FIG. 3 *a* – *m*.

SHELL subovate or subquadrate, sometimes longitudinally oval. Ventral valve longitudinally arcuate, gibbous in the middle, the greatest convexity about halfway from beak to base, with a shallow depression in front which extends upwards not more than one-third the length of the valve, and is not seen in young specimens : beak elevated and closely incurved over the opposite one. Dorsal valve abruptly elevated in the middle, and somewhat flattened at the sides.

SURFACE marked by a few strong lamellæ indicating periods of growth, and by finer parallel striæ; while the entire surface is covered by faint radiating striæ.

The casts of this species, in the dorsal valve, show the mark of a median septum reaching more than halfway to the base. The muscular impressions in the cast of the ventral valve are large and strongly defined.

This species is intermediate in form between *M. arcuata* and *M. subquadrata* of the Lower Helderberg group; being less sinuate and more distinctly striate than the former, and less produced in front, with a greater elevation on the dorsal valve, than the latter.

The radiating striæ are more distinctly shown in the figures than they should be, and appear much as the specimen does under an ordinary lens.

Fig. 3 *a*. Ventral valve of a young specimen.

Fig. 3 *b*. Dorsal view of a large specimen.

Fig. 3 *c*, *d*, *e*. Profile, ventral and front views of the same specimen.

Fig. 3 *f*. A ventral view of an intermediate form.

Fig. 3 *g*, *h*. Dorsal and ventral views of a cast of this species. (The mark of the median septum is not shown in some of the figures.)

Fig. 3 *i*. Profile view of the same.

Fig. 3 *k*. Ventral view of an imperfect cast, showing a larger muscular area.

Fig. 3 *l*. Ventral view of a large individual of this species.

Fig. 3 *m*. Profile view of the same.

Geological position and localities. In the Oriskany sandstone : Albany and Schoharie counties (New-York), and Cumberland (Maryland).

EATONIA.

In the Annual Report on the Palæontology of New-York for 1841, Mr. CONRAD described and figured a species of brachiopod from the Oriskany sandstone under the name of *Atrypa peculiaris**. A similar species was described by Mr. VANUXEM, in his Geological Report in 1843, under the name of *Atrypa singularis*†, from the Shaly limestone of the Lower Helderberg group.

These species are both remarkable in their form and exterior surface markings; having one valve deeply sinuate on its anterior margin, and the other with a long linguiform extension filling the sinuosity, while the surfaces are finely marked by radiating striæ. A third species, described by Mr. VANUXEM as the *Atrypa medialis*, was placed in the same group with the two preceding, though the external appearance would scarcely justify such an arrangement.

In the course of continued collections in the Helderberg, numerous casts of these species were obtained; and it became apparent that they possessed a peculiar internal structure, leaving upon the casts similar muscular and vascular impressions. For these forms I proposed, in 1856, the name EATONIA‡, describing several species. The genus may be characterized as follows:

GENUS EATONIA‖ (HALL, 1856).

GENERIC DESCRIPTION. Shell oval or ovoid, subcircular, elongate or transverse. Valves very unequally convex, with a strongly developed mesial fold and sinus. Beak perforate.

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* Annual Report on the Palæontology of New-York, 1841, pa. 56, pl. f. 11.

† Report on the Third Geological District of New-York, 1843, p. 120, f. 3.

‡ *In memoriam* Professor AMOS EATON, Principal of the Rensselaer School in Troy, from its establishment in 1824, to his death in 1842.

‖ Report of the Regents of the University on the State Cabinet of Natural History for 1856, published 1857. Also New Species of Palæozoic Fossils, 1857.

The ventral valve is usually nearly flat or slightly convex near the beak, flattened or concave in the middle, with a broad deep sinus extending thence to the front of the shell; the anterior extension being often turned at right angles to the plane of the longitudinal axis. Beak small, elevated, and closely incurved over the umbo of the opposite valve, perforate : no area. Dorsal valve convex, often ventricose, with a deep sinus in the anterior margin. Valves articulating by teeth and sockets; the anterior and antero-lateral margins often crenulate or plicate within. The cardino-lateral margins of the ventral valve are usually angularly inflected, and embraced within the edges of the dorsal valve.

The valves articulate by means of two teeth in the ventral valve with corresponding sockets in the dorsal valve, and a medio-longitudinal ridge in the ventral valve which is more or less completely embraced between the deeply bifurcating cardinal process of the dorsal valve, which forms part of the apophysary system.

The dorsal valve has a prominent bifurcating cardinal process, the branches of which, slightly diverging, form the first or lower crural processes, which are directed upwards and inwards, or, when the valves are closed, are directed into the muscular cavity of the ventral valve (their upper surfaces slightly grooved)*. Below these first processes, and proceeding from the origin of the thickened cardinal process, another pair of crura are directed inwards, and gently curve towards the first, the medio-longitudinal ridge being continued to the centre of the valve; and on each side, from these second crural processes, a ridge proceeds along the inside of the shell nearly parallel to the margin. This ridge, or thickening of the shell, marks the extent to which the margin of the ventral extends within the edge of the dorsal valve.

* These processes correspond precisely with what are termed the crural processes in RHYNCHONELLA, and do not differ materially from the corresponding parts of *Rhynchonella psittacea*, except in their prominence or extension beyond the cavity of the shell as shown in the figures. In the older shells, at least, this process is deeply bifurcate, and grasps the medio-longitudinal septum of the ventral valve, giving additional strength to the hinge. The ultimate extension and form of these processes is still undetermined. Separate valves of the species of this genus are rarely observed even in positions where the entire shells are common, and where they would have been preserved, had they been readily separable, like many others.

In the ventral valve, the two strong teeth proceed from the thickened margin of the valve; and below these, but not distinctly connected with them, are lamellæ, which, extending into the cavity of the beak, continue downwards, forming an elevated rim around the deep muscular impression. This elevated rim, which is convergent, grasps the neck of the cardinal process of the opposite valve in its narrowest part between the two pairs of processes (figures 1, 2, 3, and 6).

The muscular area is longitudinally oval, with a strong median plate, which, about halfway from the beak to the base of the muscular impression, spreads laterally and becomes slightly raised from the shell, leaving a little cavity beneath it; and in this, and below its edge, are the cordiform adductor imprints*. The median ridge is continued below this point, but less prominently than above. When the muscular impression is perfectly preserved, it is radiatingly plicated towards the margin in all the species observed. The casts of the ventral valve show the form of this muscular impression in strong relief, and, in well-preserved specimens, the small adductor impression projects a little above the level of the other part.

The muscular impression in the dorsal valve is somewhat central, oval or cordiform; beginning sometimes a little above the termination of the median septum, and sometimes nearer the beak, and expanding towards the front of the shell. This impression is margined by a slightly elevated rim, and in some species there is a double rim.

The points of similarity with RHYNCHONELLA will at once be observed on comparison of this description with that of the former genus, or on comparison with the fossils themselves. The most striking difference in the ventral valve is the absence of dental plates, strictly speaking; though these are represented in the elevated lamellæ surrounding the muscular impression, which is much stronger and differs in some respects from that of *Rhynchonella*. In some of the palæozoic Rhynchonellæ there are no dental plates visible, and the muscular impression is but faintly defined. In the median septum of the ventral valve, which in the older shells articulates with the central process of the opposite one, there is a character not observed in *Rhynchonella* proper. The most conspicuous difference, however, is in the dorsal

* See figures 3 and 4, page 485.

valve and its four crural processes, which differ essentially from *Rhynchonella*, or any other brachiopod known to me.

I have not discovered the deltidial plates, though they have probably existed. The foramen appears to be formed on the lower side by the umbo of the opposite valve; and, in the young state, there is room for the protrusion of a small pedicle; while in older shells, where these parts have been seen, there appears to be a thickening of the shell, and a closing of the passage to the beak.

The surfaces of these shells are radiatingly striate or plicate; one of the most conspicuous external features being the broad deep sinus on the lower half of the ventral valve, and the abrupt upward bending of the front of the shell.

Hitherto I have not distinguished any species in the Lower Silurian rocks; and, in the State of New-York, they are confined to the Lower Helderberg group and the Oriskany sandstone.

Under this genus, the *Eatonia medialis*, *E. eminens*, *E. singularis* and E. *peculiaris* are described on pages 241, 242, 243 and 244 of this volume*.

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* The following illustrations are from the Report of the Regents of the University on the State Cabinet of Natural History for 1858 :

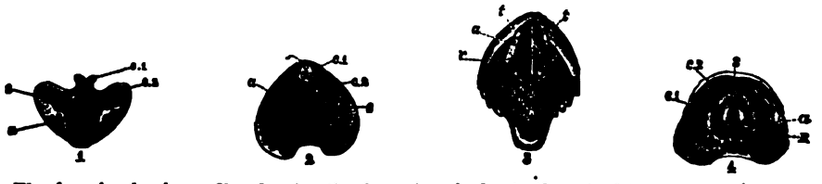

Fig. 1. The dorsal valve in profile, showing the deep sinus in front, the crural processes (*c* 1 and *c* 2); the median septum (*s*), and muscular impression (*a*).

Fig. 2. The dorsal valve, looking vertically into the interior. The upper crural processes (*c* 2) are not quite sufficiently divergent.

Fig. 3. The ventral valve, showing the form of the muscular impressions (*a*, *R*) and the teeth (*t*).

Fig. 4. The ventral valve preserving a part of the dorsal valve attached, showing the first crural processes (*c* 1) extending into the muscular cavity. The extension of the shell in front is broken off, to show the interior.

Fig. 5. Profile of the ventral valve, showing the teeth and the elevation of the shell at *R* the lower limit of the muscular impression.

Fig. 6. Another specimen (the figure enlarged) with the dorsal valve downwards, showing the median septum of that valve (*s*), and the crural processes with the median septum of the ventral valve (*s*) embraced between the processes (*c* 1). The muscular cavity of the ventral valve (*R*) is limited by inflected lamellæ, which embrace the neck of the cardinal process of the dorsal valve.

Eatonia peculiaris.

PLATE CI. FIG. 2 *a* – *g*; and PLATE CI A. FIG. 1 *a* – *h*.

For description of the species, see page 244 of this volume.

PLATE CI.

Fig. 2 *a*, *b*, *c*. Dorsal, ventral and profile views of a specimen, having the ordinary form and proportions of this species in the Oriskany sandstone.

Fig. 2 *d*. A cast of the dorsal valve of this species, showing the median septum and lateral lamellæ.

Fig. 2 *e*. A cast of the ventral valve, showing the form of the muscular impression, the median septum, and the small points of attachment for the adductor muscles.

Fig. 2 *f*. A specimen preserving a portion of the shell, which, on one side, is penetrated by the ramifying vessels. (The lamellose structure of the shell is confounded with the surface striæ in the figure, which gives it an unnatural appearance.) Figure enlarged to one and a half diameters.

Fig. 2 *g*. A cast of the ventral valve, showing the muscular and vascular impressions (See corrected figure on Plate CI A).

PLATE CI A.

Fig. 1 *a*. Interior of the ventral valve, showing the form of the muscular impressions, teeth, etc.

Fig. 1 *b*. Profile of the same, showing the little elevations of the shell-surface, and the small pits for the adductor muscles *a*, and the teeth *t*.

Fig. 1 *c*. The dorsal valve, showing the crural processes and muscular impression.

Fig. 1 *d*. Front view of the same, showing the deep sinus, and the relation of the crural processes and median septum.

Fig. 1 *e*. Section of the dorsal valve, showing the elevation of the median septum and the crural processes.

Fig. 1 *f*. Figure of the ventral valve (the inflected extension in front being removed) with a part of the dorsal valve attached, showing the crural processes *c* 1 and *c* 2, and the median septum of the dorsal valve; *a*, the adductor imprints, showing the small oblique pits penetrating beneath the laminæ of the shell; *r*, the cardinal muscular impression.

Fig. 1 *g*. View of another specimen with the dorsal valve downwards and the ventral valve broken away, to show the median septum articulating with the bifurcating cardinal process of the dorsal valve.

Fig. 1 *h*. A cast of the ventral valve, showing the muscular and vascular impressions. This and the preceding figure are enlarged to once and a half the natural size.

Geological position and localities. In the Oriskany sandstone: Albany, Schoharie, and Greene counties (New-York); Cumberland (Maryland), and other places.

Eatonia pumila (n. s.).

PLATE CI. FIG. 1.

SHELL small; length and breadth nearly equal. Cast of the ventral valve flat in the middle and deeply sinuate in front; margins crenulate below the middle of the shell; beak acute; cavities of the teeth deep and strong : muscular area narrow, the points of the adductor muscle being visible only under a lens. The medio-longitudinal ridge is continued below the middle of the valve.

This small species has been recognized only in the cast of a ventral valve, which is very distinct from any of the others in its narrow elongate muscular impression and pointed beak. The surface has probably been finely striated, like the *E. peculiaris* and *E. singularis*.

Fig. 1. The cast of the ventral valve, natural size.

Geological position and locality. In the Oriskany sandstone : Albany county.

Eatonia whitfieldi (n. s.).

PLATE CI A. FIG. 2 *a*, *b*.

SHELL longitudinally suboval, wider below than above. Ventral valve depressed convex near the beak, flat in the middle, and broadly depressed towards the front.

SURFACE radiatingly plicated : plications rounded, about eight or nine on each side of the mesial one, which is a little stronger than the others.

Muscular impression of the ventral valve broad, and not strongly defined: crural processes short.

The specimens examined are an imperfect ventral valve, and another ventral valve preserving the beak of the dorsal valve and the crural processes in part.

Fig. 2 *a*. The exterior of the ventral valve.

Fig. 2 *b*. The interior of the ventral valve, with the apex of the dorsal valve attached. The specimens yet obtained are too imperfect to give more complete illustrations.

Geological position and locality. In the Oriskany sandstone : Cumberland, Md.

Eatonia sinuata.

PLATE CI A. FIG. 3 – 6.

Eatonia sinuata : HALL, Regents' Report for 1856, p. 91; Palæozoic Fossils, 1857, p. 51.

SHELL circular or longitudinally oval. Ventral valve concave, except in the umbonial region, whence, as well as from the lateral margins, it slopes gradually into the broad deep sinus without defined margins. Dorsal valve convex, rising from the middle towards the front into a broad undefined mesial prominence, which is often nearly as high as the highest part of the central region of the valve : beak incurved.

SURFACE marked by thirty-six to forty strong elevated rounded or subangular plications on each valve.

Muscular impressions large, broad, and marked with radiating plications towards the margin, strongly defined by an elevated border : impression of the adductor muscles cordiform, small, located in the middle of the large muscular area.

The two middle plications on the dorsal valve are separated by a wider depression, than between those on other parts of the shell, which continues quite up to the beak : in this depression there is sometimes near the front a slender plication, which becomes obsolete before reaching the beak.

The surface of the shell was doubtless also marked by fine concentric lines of growth, but none of the specimens which have come under my observation are in a condition to have preserved them.

This species differs from *E. medialis* in being proportionally more elongate, having more plications, and a broader and less distinctly defined sinus in the ventral valve. The two plications bordering the sinus and mesial fold of the former species are also proportionally much broader than in this one.

Fig. 3 *a*. Dorsal view of a large individual, which shows the prevailing form.

Fig. 3 *b*, *c*. Profile and front views of the same.

Fig. 4. Dorsal view of a more orbicular form.

Fig. 5. Ventral view of a cast, showing the strong muscular impression with the small central adductor impression.

Fig. 6. Ventral view of a cast preserving a part of the shell ; the form of the shell and muscular impression more rotund than the preceding.

Geological position and locality. In the Oriskany sandstone : Cumberland, Md.

Rhynchonella oblata.

PLATE CII. FIG. 1? & 2 *a* – *d*.

Rhynchonella oblata : HALL, Regents' Report of 1856, p. 86; Palæozoic Fossils, 1857, p. 46.

SHELL subcircular, somewhat compressed. Dorsal valve the larger, depressed convex, declining with a gentle curve towards the lateral margins, rising in front into a broad round undefined mesial fold : beak somewhat incurved. Ventral valve much compressed, depressed convex in the middle and umbonial regions, and depressed into a broad shallow undefined sinus in front.

SURFACE marked by seventy-five to eighty coarse striæ, which occasionally bifurcate, and of which twelve to fourteen or more mark the mesial fold and sinus.

The specimen fig. 1, which is referred with doubt to this species, preserves a part of the shell : the other specimens are casts. The muscular area of the ventral valve is comparatively small, and the space for the adductors quite narrow. The ramifying vascular impressions are beautifully preserved in a single specimen, radiating from the muscular area and extending to the cardinal line, where they are strongly marked. In the dorsal valve the medio-longitudinal septum extends from the beak nearly halfway to the base of the shell, the cast sometimes showing the marks of muscular impressions. The impressions of the radiating striæ are preserved on the lower half of the casts.

Fig. 1. A young individual, retaining a part of the shell on the dorsal valve.

Fig. 2 *a*. Front view, showing the broad shallow sinus.

Fig. 2 *b*. The ventral side of another specimen, showing the muscular area and the ramifying vascular impressions. (The latter are represented in lines too sharply defined : the two sides are not connected by a sharp line, as shown in the figure; and their extension towards the front of the shell is in shallow depressions, which gradually become obsolete.)

Fig. 2 *c* & *d*. Dorsal and cardinal views of the same specimen.

Geological position and locality. In the Oriskany sandstone : Albany and Schoharie counties.

Rhynchonella multistriata.

PLATE CII. FIG. 3; and PLATE CVI. FIG. 3.

Rhynchonella multistriata : HALL, Regents' Report for 1856, p. 85; Palæozoic Fossils, 1857, p. 45.

SHELL depressed suborbicular. Ventral valve depressed convex, most elevated in the umbonial region, flattened towards the lateral margins and depressed in front, forming a broad shallow undefined sinus. Dorsal valve unknown.

SURFACE marked by numerous fine regular bifurcating striæ, which are well defined nearly to the apex of the beak.

This species is more finely striated than the preceding, and is more nearly circular in form, the length and breadth being about equal; while in the casts of that one, the width is greater than the length.

PLATE CII, fig. 3. View of the dorsal valve.
PLATE CVI, fig. 3. An imperfect dorsal valve of a younger specimen.

Geological position and locality. In the Oriskany sandstone : Helderberg mountains.

Rhynchonella pleiopleura.

PLATE CII. FIG. 3 *a* – *c* & 4 *a* – *c*.

Atrypa pleiopleura : CONRAD, Annual Report on the Palæontology of New-York, p. 55.
Rhynchonella pleiopleura : HALL, Regents' Report for 1856, p. 86; Palæozoic Fossils, 1857, p. 46.

SHELL transversely oval. Dorsal valve the larger, somewhat gibbous, having a round undefined mesial fold : beak incurved; cardinal border excavated in deep fossets on each side of the beak, for the reception of the dental lamellæ of the opposite valve. Ventral valve nearly flat, most elevated near the beak, having a somewhat deep broad rounded sinus near the front margin, which is prolonged into a rounded or subtriangular projection.

SURFACE ornamented by from sixty-four to seventy subangular bifurcating striæ or plications.

This species has been found only in casts, or preserving portions of the shell. It differs from *R. oblata* in being more deeply sinuate, with coarser and more angular striæ. The muscular impression of the ventral valve is proportionally larger and stronger, and the whole shell is more robust.

Fig. 3 *a*. A ventral view of a cast. The area of the muscular impression is not sufficiently defined.

Fig. 3 *b*. Dorsal view of the same specimen, showing a greater convexity of the valve, and a shorter medio-longitudinal septum than the *R. oblata*.

Fig. 3 *c*. Front view of the same.

Fig. 4 *a*. A larger individual. The specimen is somewhat broken and distorted.

Fig. 4 *b* & *c*. Dorsal and profile views of the same.

Geological position and locality. In the Oriskany sandstone : Albany and Schoharie counties.

Rhynchonella fitchana.

PLATE CIII. FIG. 1 *a*, *b*.

Rhynchonella fitchana : HALL, Regents' Report for 1856, p. 85; Palæozoic Fossils, 1857, p. 45.

SHELL longitudinally oval or ovate. Dorsal valve very convex : cardinal margin excavated on each side of the beak, for the reception of the dental laminæ of the other valve. Ventral valve depressed-convex, most elevated in the umbonial region, flattened towards the lateral margins and depressed in front, forming a faint broad and undefined sinus.

SURFACE ornamented by about seventy-five angular plications, which sometimes bifurcate.

This species resembles the *R. pleiopleura*, but is much less distinctly sinuate, and with no perceptible mesial fold on the dorsal valve. The muscular impression on the ventral valve is small and well defined; being less than in *R. oblata*, and less than half the size of that in *R. pleiopleura*, while the plications are stronger than in either of those.

This species, with several others, was received from ALEXANDER FITCH, esquire, of Carlisle.

Fig. 1 *a*. The dorsal side of the specimen, which preserves a part of the shell.

Fig. 1 *b*. Profile view of the same.

Geological position and locality. In the Oriskany sandstone : Carlisle, Schoharie county.

Rhynchonella barrandi.

PLATE CIII. FIG. 3 – 8.

Rhynchonella barrandi : HALL, Regents' Report for 1856, p. 82; Palæozoic Fossils, 1857, p. 42.

SHELL very large, ovoid or subglobose; full-grown specimens higher than wide, vertically flattened on the sides. Dorsal valve very convex, often extremely elevated : beak incurved; cardinal border on each side of the beak profoundly sinuate. Ventral valve much the smaller, strongly arcuate longitudinally, having a broad shallow rounded sinus towards the front, abruptly inflected at the lateral margins which are distinctly angular, prolonged in front into a broad rounded linguiform projection which fills the sinus in the opposite valve.

SURFACE marked by thirty to forty simple (rarely bifurcating) strongly elevated plications on each valve, as shown in casts of the interior : plications rounded or subangular.

This species has occurred only in casts, which are generally more or less distorted. It is the largest of the genus known to me in the rocks of the country. The great size, with the strongly marked internal characters which are impressed upon the cast, will serve to distinguish this species from any other yet known.

In many respects it resembles *R. speciosa*, which may be regarded as a representative form in the Maryland rocks : it is, however, distinguished from that shell by its larger size, its more elevated dorsal valve and relatively broader form, and its broad shallow rounded sinus near the front of the ventral valve.

Fig. 3. Cast of the ventral valve, showing the large muscular impression. The area of the adductor muscles is not represented as large as in the specimen. The depression in front is less than one-eighth of an inch below the plane of the more prominent margins.

Fig. 4. A similar cast of a smaller individual, in which the form of the rostral cavity is better preserved than in the preceding. The casts show a great thickening of the shell at the beak.

Fig. 5. Cardinal view of a specimen which is a cast from the interior of both valves, showing the great elevation of the dorsal valve, the strong median septum, and the deep sinuosity on each side of the beak.

Fig. 6. Front view of the same specimen.

Fig. 7. Lateral view of the same, showing the great lateral extension of the dorsal valve.

Fig. 8. Profile view of a cast of the ventral valve, showing the abrupt inflection at the margin and the expansion of the shell below the beak, which fills the lateral sinuosities in the opposite valve.

Geological position and localities. In the Oriskany sandstone : Albany and Schoharie counties.

Rhynchonella principalis.

PLATE CVI. FIG. 4.

Rhynchonella principalis : HALL, Regents' Report for 1856, p. 84; Palæozoic Fossils, 1857, p. 44.

SHELL longitudinally ovate. Dorsal valve unknown. Ventral valve depressed convex, forming a low elliptical arch from beak to front, most prominent along the middle, flattened or somewhat concave near the lateral margins, which are abruptly inflected towards the opposite valve: beak somewhat prominent, and moderately incurved; front slightly concave, but not distinctly sinuate.

SURFACE ornamented by about eighty regular rounded plications, which occasionally bifurcate, and are crossed by indistinct lines of growth.

This species is closely related to *R. barrandi;* and having but a single ventral valve, I cannot readily decide how far it may differ in its entire characters. The casts of the preceding species are all proportionally broader when not compressed, have a more distinct sinus in front, and fewer plications. With the knowledge at present possessed, this species may be considered as holding a place intermediate to the very well marked *R. speciosa* and the equally well marked *R. barrandi.*

Fig. 4. View of the ventral valve, natural size.

Geological position and locality. In the Oriskany sandstone : Auburn, Cayuga county. From Professor HOPKINS.

Rhynchonella septata (n. s.).

PLATE CIII. FIG. 2.

The specimen is a cast of the dorsal valve, which shows, near its margin, indistinct marks of a few plications, with the impression of a median septum reaching nearly to the base, which has been extremely thickened towards the beak. The crural processes have been very large and strong, and projecting above these was a strong bilobed process.

Geological position and locality. In the Oriskany sandstone : Albany county.

Rhynchonella speciosa.

PLATE CIII A. FIG. 1 – 6.

Rhynchonella speciosa : HALL, Regents' Report for 1856, p. 81; Palæozoic Fossils, 1857, p. 41.

SHELL longitudinally ovoid, vertically flattened on the sides, higher than wide, abruptly rounded or subtruncate in front; sides nearly parallel: no sinus in either valve. Dorsal valve extremely elevated, abruptly inflected on each side towards the opposite valve : beak incurved; cardinal margin on each side of the beak profoundly sinuate, for the reception of the rounded auriculate processes of the opposite valve; anterior and lateral margins uniting by sharp prominent interlocking serrations. Ventral valve depressed convex near the beak and flattened in the middle, forming a regular elliptical arch from beak to front, and abruptly inflected at the sides so as to form distinct angles along the lateral margins, the entire front of the valve forming a broad truncated projection : beak somewhat obtuse, incurved.

SURFACE marked by strongly elevated, rounded or very obtusely subangular plications, each of which, on the front and sides of the shell, has a fine depressed line along the centre, crossed by fine regular concentric zigzag lines of growth.

The interior of the ventral valve shows a very distinct oval muscular impression, in which the adductors are but faintly defined : the median division is very faint. The dental processes are small and slender, and placed just within the edge of a prominent auricular extension of the valve which fills the sinus of the opposite one. The margins of the valve, from the dental process to the beginning of the anterior portion, are inflected at right angles to the transverse axis or plane of the valve. The marks of the plications extend into the interior nearly as far as the muscular impression.

The interior of the dorsal valve shows an elevated median septum,

extending from beneath the thickened cardinal process for one-third the length of the shell. The crural processes are comparatively long and slender, and, at their base, are separated by a prominent callosity. In older shells this callosity becomes thickened and duplicated; and the median groove in the cardinal process at the base of the crura, lying below the plane of the beak, becomes filled up, and the process extended above the beak, with an oval impression on each side.

This beautiful shell is remarkable for its regular ovoid form and vertically compressed sides. It differs from any other species of equal size known to me, by the entire absence of a sinus in either valve. Adult specimens appear to have been generally higher than wide, though in younger individuals the width is greater than the height.

Fig. 1 *a*. Dorsal view of a specimen of medium size.

Fig. 1 *b*. Profile of the same, showing some parasitic bodies attached at the front and sides.

Fig. 2 *a*. Dorsal view of a larger individual.

Fig. 2 *b* & *c*. Profile and front views of the same.

Fig. 2 *d*. Cardinal view, showing the deep sinuosities in the dorsal valve and the auricular extensions of the ventral valve.

Fig. 3. A partial cast of a large individual of this species.

Fig. 4 *a*. The ventral valve, showing the muscular impression : the teeth are broken off.

Fig. 4 *b*. A fragment of a dorsal valve, showing the muscular impression, teeth, etc.

Fig. 4 *c*. Cardinal view of the preceding specimen.

Fig. 5. The rostral portion of a specimen, showing the junction of the two valves, the median septum in the dorsal valve, and the crural processes of the ventral valve.

Fig. 6 *a*. The interior of the dorsal valve, showing the median septum, the crural processes, the thickened cardinal process with the prominent bilobed summit, and the dental fossets.

Fig. 6 *b*. Cardinal view of the preceding specimen, showing the sinuosities on each side of the beak, the cardinal and crural processes.

Geological position and locality. In the Oriskany sandstone : Cumberland, Md.

Rhynchonella ramsayi (n. s.).

PLATE CI A. FIG. 7 & 8 *a*, *b*.

SHELL longitudinally ovate, valves equally convex, gibbous towards the umbones and declining towards the front and sides, symmetrically rounded in front, with moderate sinus and elevation below the middle. Ventral valve convex in the middle and gradually tapering to the beak, which is small and neatly incurved over the umbo of the opposite valve, the truncated extremity being on a plane with the axis of the shell; the margins on each side, below the beak, slightly auriculate. Dorsal valve most convex at the first third from the beak : margins on each side, below the beak, moderately sinuous.

SURFACE marked by thirty-six to forty or more slender rounded plications on each valve, about fourteen of which, in the centre and near the front, become a little larger and more prominent than the others on the dorsal valve, while an equal number on the ventral valve are just perceptibly depressed.

The cast shows a defined longitudinally oval muscular impression on the ventral side; while the dorsal side shows the mark of the median septum, and the cavities made by the slender crural processes.

This species is quite distinct from any other known to me in the Lower Helderberg and Oriskany sandstone; being less gibbous than any one of the same size, while the mesial elevation is scarcely perceptible, except in the greater size and slightly greater prominence of the plications.

Fig. 7. View of the dorsal side of the specimen.
Fig. 8 *a*, *b*. Ventral and dorsal views of the cast of this species.

Geological position and locality. In the Oriskany sandstone : Cumberland, Md.

GENUS LEPTOCŒLIA (HALL, 1856).

Regents' Report on the State Cabinet of Natural History for 1856, published 1857.

GENERIC DESCRIPTION. Inequivalved, variable in form, usually semioval or subcircular, transverse or elongate, plano-convex or concavo-convex: hinge-line sometimes equal to the greatest width of the shell. Ventral valve convex or subangular in the middle, with beak more or less extended, moderately incurved; foramen terminal, the lower side formed by two deltidial pieces. Dorsal valve flat or concave, or depressed-convex. A mesial fold and sinus usually existing, but not often prominent. Structure of shell lamellose or fibrous, not punctate.

Valves articulating by means of two strong teeth in the ventral, inserted into sockets in the dorsal valve, which are mainly excavated in the base of a strong cardinal process: teeth converging. Muscular impressions marking a large ovate or flabelliform area with a thin median septum: adductor imprints small.

The dorsal valve is marked by a strong cardinal process, at the base of which, on each side, are the deep oblique dental fossets; and from the inner margins of these proceed the crural processes, supported below by thickened plates which extend obliquely for a short distance towards the middle of the shell, bordering the muscular impression. The muscular impression forms a suboval space, divided through the middle by a low median septum.

The crura, in their extension, are united in a flattened disk, which terminates at its remote extremity in an acute point, with a central projection pointing upwards; while at the junction of the crura with the disc there is, on each side, a slender process continued downwards into the cavity of the ventral valve. The cardinal process, in its central portion, is thickened at first and divided in the middle, but, in old shells, gradually filling the passage to the foramen, and sometimes by a prominent point in the centre entirely dividing the passage.

The hinge-line is often much extended, and in the dorsal valve nearly straight to the cardinal angles. There is sometimes the appearance of a false area on the ventral valve, somewhat similar to ATRYPA, the margin being thickened and grooved; but this does not appear to be a characteristic or constant feature.

The specimens of the interior, which have fallen under my observation, usually preserve only the short crural processes; and it is in one specimen alone, which is partially filled with crystalline matter, that distinct cavities can be seen corresponding with what I have described. The crystalline matter was first deposited upon these internal organs, which have subsequently almost entirely decomposed, leaving in the cavities fragments of the substance, showing the original form of the crura and appendages.

The shells of this form have been described as TEREBRATULA, and more recently have been included with RHYNCHONELLA, from which they differ conspicuously in the great inequality of the valves and the extension of the hinge-line, as well as in their internal structure.

I have heretofore referred to this genus the *Leptocœlia* (*Atrypa*) *disparilis* of the Niagara group, the *Terebratula lepida* of GOLDFUSS, the *T. sublepida* and *T. duboisi* of MM. MURCHISON, DE VERNEUIL and KEYSERLING (Geology of Russia and the Ural Mountains). The *L. concava* and *L. imbricata* of the Lower Helderberg group are analogous forms, which have been referred to this genus. The *Atrypa hemispherica* of MURCHISON is apparently a characteristic form of this genus, as well as the *A. planoconvexa*, both of the Clinton group*. The internal structure, however, has been determined from the species of the Oriskany sandstone and Lower Helderberg specimens, but mainly from the former.

In its hinge structure it approaches TROPIDOLEPTUS; but the hinge-line of the dorsal valve is never so far produced, while the beak is much more extended. In TROPIDOLEPTUS there is a distinct linear area, and the teeth and sockets are strongly crenulated; the form and character of the muscular impressions are different, and the structure of the shell is punctate.

Geological range. The genus begins its existence as low down in the system as the Clinton group, and extends through all the members of the series to the limestones of the Upper Helderberg, and perhaps above that point.

* The last-named species presents some differences in the hinge structure, which may prove of sufficient importance to unite the lower group of species under another generic designation.

Leptocœlia flabellites.

PLATE CVI. FIG. 1 *a* – *f*; and PLATE CIII B. FIG. 1 *a* – *f*.

Atrypa flabellites : CONRAD, Annual Report on the Palæontology of New-York for 1841, p. 55.
*Leptocœlia propria** : HALL, Regents' Report of 1856, p. 108; Palæozoic Fossils, 1857, p. 68.

SHELL somewhat semielliptical, varying to suborbicular or transversely oval, generally broader than long. Ventral valve convex, most prominent along the middle, declining laterally: beak incurved, with a small round perforation in the extremity, which is completed on the lower side by the two deltidial pieces; or, in the absence of these, the foramen is completed by the umbo of the dorsal valve. Dorsal valve flat: beak straight; hinge sloping from the beaks at an angle of 110° to 160°, rounded at the extremities.

SURFACE marked by ten to fourteen simple angular plications; two of which, on the middle of the ventral valve, are a little larger and slightly more prominent than the others; and, between these, there is a third smaller depressed plication, forming an indistinct sinus. On the dorsal valve the two middle plications are a little closer together, and slightly more prominent near the front, than the others; while the depressions separating them from these, each side, are a little wider and deeper than those between the other plications.

This species presents some varieties of form, apparently due to age and other influences; the hinge-line of some individuals being often more extended and more nearly straight. The extension of the beak varies in different individuals, and in those from different localities. The silicified condition of the specimens has obscured the finer surface markings. Many of the specimens appear to retain remains of fine radiating striæ; while more distinct concentric lines, and occasional stronger undulations of growth, are visible in most of them.

In specimens from New-York, Maryland and Canada, which I have referred to this species, there are some slight differences which appear to be due to the condition of the sediments in the different localities.

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* I had overlooked the description of Mr. CONRAD of *A. flabellites*, as designating this species, at the time I published the descriptions of new palæozoic fossils; and it is only as these pages are going through the press that my attention has been directed to the subject, leaving no doubt of the identity of the species.

PLATE CVI.

Fig. 1 *a*, *b*, *c*, *d*. Dorsal, ventral and profile views of this species. (The figures, unfortunately, represent too many plications by two on each side of the centre.)

Fig. 1 *e*. The interior of the dorsal valve, showing the cardinal process, etc.

Fig. 1 *f*. A cast or impression of a larger dorsal valve.

The preceding, with a few specimens in similar condition, are all that I have been able to obtain from the Oriskany sandstone in New-York.

The following illustrations have been made from a study of the Maryland collections at a later period:

PLATE CIII B.

Fig. 1 *a*, *b*. Ventral and dorsal views of a specimen of this species.

Fig. 1 *c*, *d*. Profile view of a specimen of the ordinary form of this species.

Fig. 1 *e*. Interior of specimen with rounded extremities.

Fig. 1 *f*. Interior of the dorsal valve of this species.

Geological position and locality. In the Oriskany sandstone: Albany, Schoharie, Greene and Ulster counties (New-York); Cumberland (Maryland), and in Virginia and Canada.

Leptocœlia fimbriata (n. s.).

PLATE CIII B. FIG. 2 *a* – *f*.

SHELL small, longitudinally semielliptical, the length less than the width. Ventral valve convex, more elevated along the middle, declining regularly at the sides, the cardinal angles somewhat compressed: beak small, little elevated above the cardinal line and slightly incurved, with a minute rounded foramen at the extremity, the lower side of which, when entire, is completed by two small deltidial pieces. Dorsal valve flat or slightly convex, the front and lower lateral margins abruptly inflected: beak straight; hinge-line of the ventral valve more declining, with border often grooved for the reception of the edge of the dorsal valve. The hinge-line of closed valves often ornamented by fibres or fimbria, forming a byssus-like appendage.

SURFACE marked by about eleven or twelve rounded or subangular plications on each valve, two of which, in the middle of the ventral valve, are more prominent and slightly larger than the others; and between

these there is a third (usually) smaller depressed plication, with a shallow sinus below the middle of the shell. On the dorsal valve the two central plications, below the middle, are a little stronger and more widely separated from the lateral ones, rising in front into a slight mesial elevation. When seen from the front, the margin of the shell presents a very distinct sinus, with a corresponding projection of the opposite valve, the entire margin being deeply serrate. The finer surface markings are mostly obliterated, some imbricating lines of growth alone remaining.

The fimbriated appendage along the hinge-line has been observed in so many specimens, that I can only suppose it to belong to the animal economy. The remains of this appendage are sometimes observed upon the inner margins of the separated valves.

This species differs from the preceding in the proportionally wider and less sloping cardinal line, and in the less extension of the beak of the ventral valve, which is smaller and more neatly defined; in the fewer plications and comparatively greater convexity of the ventral valve, while the dorsal valve is slightly convex and abruptly inflected at the margin, features not observable in *L. flabellites*.

In the localities where this species occurs, often in large numbers, few or no specimens of the *L. flabellites* are found; while in localities where the surfaces of the layers are covered with the latter shell, no specimens of *L. fimbriata* have been seen.

Fig. 2 *a*, *b*. Dorsal and profile views of a specimen of ordinary size.

Fig. 2 *c*. Front view of a specimen a little greater than the ordinary size, and which has the fimbriated expansion extending below the cardinal angles.

Fig. 2 *d*. The ventral side of the preceding specimen, enlarged two diameters.

Fig. 2 *e*. The interior of the ventral valve, showing the cardinal teeth and the muscular impression.

Fig. 2 *e*. The interior of the dorsal valve, showing the muscular impression, the cardinal process, the oblique lamella, median septum and bases of the crural processes.

Fig. 2 *f*. The same enlarged.

Geological position and locality. In the Oriskany sandstone : Cumberland, Md.

Leptocœlia dichotoma (n. s.).

PLATE CIII B. FIG. 3 *a*, *b*, *c*.

SHELL oval ovate, concavo-convex. Ventral valve arcuate, strongly convex, or approaching to subcarinate in the middle and abruptly sloping at the sides : beak incurved. Dorsal valve concave, more abruptly depressed in the centre, and flattened on the cardino-lateral margins.

SURFACE marked by dichotomizing plications; the central one of the dorsal valve becoming tripartite, and the three lateral ones, which are simple at their origin, bifurcating and making six at the margin of the shell : on the ventral valve there are two smaller plications in the centre, and four dichotomizing ones on each side; concentrically marked by a few imbricating lines of growth.

This species resembles *L. concava* of the Lower Helderberg rocks, but is much larger, and the manner of bifurcation of the plications is very distinctive. The depressed space in the centre of the dorsal valve is not so abrupt, and the flattened portion on the dorso-lateral margins is proportionally much narrower than in the species from the limestone.

Fig. 3 *a*. Dorsal view of the specimen.
Fig. 3 *b*. Ventral view of the same.
Fig. 3 *c*. Front view, showing the outline, the depression of the dorsal valve, and the incurved beak.

Geological position and locality. In the Oriskany sandstone : Cumberland, Md.

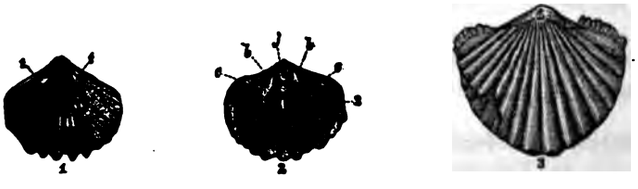

Fig. 1. The ventral valve of *L. flabellites*, showing the dental processes and the muscular impression.
Fig. 2. The dorsal valve, showing the cardinal processes, dental fossets, muscular impressions, etc.
Fig. 3. Dorsal view of *L. fimbriata*.

RENSSELÆRIA.

THE species which I have grouped under this designation, have, in some of their forms, been described as TEREBRATULA, ATRYPA and PENTAMERUS, and more recently I have referred them to MEGANTERIS; to neither of which genera do they belong. One of the most common species in the Oriskany sandstone attracted attention in the collections which were made at the Helderberg mountains forty years ago, and specimens are preserved in the "Clinton Collection" of the Albany Institute. Prof. AMOS EATON, in his Geological Textbook published in 1832 (page 45), recognizes two species which he notices as *Terebratula ovoides* and *T. perovalis;* but since he remarks that they are found "also in all parts of Europe in the same rock," it is to be presumed that he regarded these forms as identical with the European species of the same names.

In 1839, Mr. CONRAD described the more common form from the Oriskany sandstone as *Atrypa elongata**;* a name adopted by the geologists of New-York, and perpetuated in their reports. He also describes a species of that genus, from the Lower Helderberg group, as *Atrypa æquiradiata*†.

In 1843, Mr. VANUXEM described a species of this genus, from the Upper Helderberg limestone, as *Pentamerus elongata*‡.

These fossils, though presenting considerable variety when compared in their extreme forms, nevertheless constitute a very natural and beautiful group, easily recognized both in their external and internal characters||.

* Annual Report on the Palæontology of New-York, 1839, p. 65.

† Journal of the Academy of Natural Sciences, Vol. viii, 1842, p. 266.

‡ Geological Report of the Third District of New-York, 1843, pp. 132 & 133, f. 1.

|| In 1855, after having studied the exterior of the shell and its structure, together with the casts which I had obtained in New-York, I proposed for these fossils a distinct generic designation; but receiving, soon afterwards, Mr. DAVIDSON'S paper "On the systematic arrangement of recent and fossil brachiopoda," published in the Annals and Magazine of Natural History for December 1855, I observed for the first time, in the accompanying improved table of genera, the name of *Meganteris* (SUESS), with a reference to *Terebratula archiaci* as the type of the genus. The figure given in the Palæontographica so much resembles the casts of some of the Rensselæriæ, that I inferred the two to be identical, and have thus described these fossils in my paper published in the Regents' Report for 1856 (Palæozoic Fossils, 1857); and it was not until recently (1858) that my correspondence with Mr. DAVIDSON and Mr. SUESS, and the reception of the paper of Mr. SUESS on the Genus MEGANTERIS, with illustrations, has satisfied me that this genus is quite distinct from the RENSSELÆRIA.

GENUS RENSSELÆRIA* (HALL).

Terebratula : EATON, 1834 – 1842.
Atrypa : CONRAD, 1839.
Pentamerus : VANUXEM, HALL, 1843.
Atrypa : VANUXEM, MATHER, HALL, 1843.
Meganteris : HALL, 1856 & 1857.
Rensselæria : HALL, 1858.

GENERIC DESCRIPTION. SHELL inequivalved, oval, ovoid or suborbicular, elongated or rarely transverse and sometimes subtriangular, generally gibbous or ventricose. Valves more or less convex, without mesial fold or sinus : beak prominent, acute, more or less incurved; foramen terminal, sometimes concealed, round or oval, the lower side formed by two small deltidial pieces, and, in their absence, by the umbo of the opposite valve, and then appears triangular. Shell structure distinctly punctate.

SURFACE radiatingly striated or finely plicated, rarely smooth?

VALVES articulating by two somewhat widely separated teeth in the ventral valve, with corresponding sockets in the dorsal valve. The diverging cardinal teeth supported by strong dental plates, which, on their anterior margins, extend about half the depth of the cavity of the valve, when they turn abruptly towards the beak, and approach each other or unite in the rostral cavity : from this point of return, there is a low ridge bounding the muscular area, which is an elongate more or less oval depression, in the centre of which the adductor muscles occupy two small narrow scars; a more or less prominent median septum extends the entire length.

In the dorsal valve, the dental sockets lie between the shell proper, and a strong, often much thickened process, from the anterior extension of which proceed the slender crural processes, first in a direct line, and

* I have given this generic designation to commemorate the name of the late Hon. STEPHEN VAN RENSSELAER, to whose munificence we owe the early geological and agricultural surveys in the State of New-York; and to whose liberality, in establishing the Rensselaer School for teaching the sciences with their application to agriculture and the arts, I conceive is due the great impulse given to the study of the natural sciences, at a period when these pursuits were little fostered in any of our institutions of learning; and if the results of the Geological Survey in New-York are entitled to any pre-eminence, we are indebted to this early influence more than to any other cause.

then one division of each, diverging into the centre of the ventral valve, terminate in acute points. On the other side the divisions extend nearly at right angles to the axis of the shell, into the cavity of the dorsal valve; and thence bending abruptly forward and gradually converging, terminate above the centre of the shell in a thin flattened or longitudinally concave plate, which, at its remote extremity, ends in an acute point, the whole being lanceolate or hastate; and from the centre of the concave margin between the crura issues a slender process, which penetrates into the cavity of the ventral valve. This process, with the two first described as extending into the cavity of the ventral valve, sometimes reach nearly to the inner side of the shell, the three gradually converging to the extremities which are near together. This peculiar apparatus is not attached to any median septum; and the broad plate is left without any support, except from the slender crura.

The cardinal process at the base of the crura is often much thickened, and sometimes extends forward into the shell much more than in others; and when it becomes thickened in old shells, is often distinctly marked by two grooves upon its summit. Behind this process and between it and the beak, there is a distinct round foramen communicating beneath with the interior cavity of the valve. The points for attachment of the adductor muscles in the dorsal valve are double.

The internal structure described has been fully determined in two species, and partially seen in others. In one species, twenty or more individuals have shown it, with some slight variations in the form of the longitudinal plate, as illustrated in the figures on Plate CVII.

The shells of this genus are usually oval or ovate in outline, and often very ventricose; some species varying greatly in their different stages of growth. At present, I know of but a single exception to the form mentioned.

In the greater number of species, the lateral margins of the shell are bent abruptly inwards, often at right angles, or still more abruptly, so as to leave an angular groove along the margin of the united valves. This character is sometimes seen in the young shell, while often it appears only in the more advanced stages of growth. The species vary greatly in size, ranging from the smallest to nearly that of the largest brachiopod of this general form in the palæozoic rocks. The largest specimens

figured have a length of three inches, and I have fragments of others which have been much larger.

The geological range of the genus, as at present known, is from the upper part of the Lower Helderberg group, through the Oriskany sandstone, and into the Upper Helderberg limestones.

In its geographical range, it is known from Gaspe in Canada East, to Virginia and Tennessee (and probably occurs in Alabama), and westerly from New-York through Canada West, Mackinac island, Ohio, Illinois and Missouri.

Rensselæria ovoides.

PLATE CIV. FIG. 1 – 4; and PLATE CV. FIG. 1 – 6.

Meganteris ovoides : HALL, Regents' Report for 1856, p. 102; Palæozoic Fossils, 1857, p. 62.
Terebratula ovoides : EATON, Geological Textbook, 1832, p. 45. (Not SOWERBY, 1812.)
T. perovalis : EATON, Ib. id. (Not SOWERBY, 1825.)
Atrypa elongata : CONRAD, Annual Report on the Palæontology of New-York, 1839, p. 65.
Not *Pentamerus elongatus* of the Onondaga limestone, VANUXEM, Geol. Report, 1842, p. 132, f. 1.
Atrypa elongata : VANUXEM, MATHER and HALL, Geol. Reports, 1843.

SHELL ovoid, elongate-ovate or elliptical-ovate in outline, gibbous or compressed, broadest above the middle, abruptly rounded towards the cardinal end, narrowing to the front, which is often depressed and rounded or subtruncate : no traces of a sinus in either valve. In gibbous specimens, the edges of the valves are incurved, and the sides vertically flattened or a little concave, often slightly contracted near the front. Ventral valve the larger, most gibbous in the umbonial region: beak (in old specimens) somewhat obtuse, clearly incurved upon the opposite. Dorsal valve convex, less elevated than the other, most prominent along the middle or a little above it, forming a low semielliptical arch from beak to front, sloping very gradually to the sides, which (in old specimens) are often so abruptly inflected as to form a distinct angular ridge extending from near the beak two-thirds of the way to the front : beak obtuse, scarcely incurved.

SURFACE marked by regular simple radiating striæ, sometimes crossed near the borders by distinct concentric wrinkles : structure punctate.

This species varies greatly in form; some individuals being very gibbous and distinctly ovate, while others are more or less compressed and very elongato-oval or narrow elliptical : the first variety was EATON's *Terebratula ovoides*, and the latter his *T. perovalis*. In the young state, the length and breadth are often equal or nearly equal.

After studying a large collection of these forms, I am satisfied that they are varieties of the same species, dependent on age and the conditions surrounding them during their existence.

PLATE CIV.

Fig. 1 *a*. The dorsal side of a young specimen, where the length little exceeds the width ; the shell nearly all exfoliated.

Fig. 1 *b*, *c*. Ventral and profile view of the cast of a larger individual, preserving a little of the shell.

Fig. 1 *d*. Cardinal view of a cast of a specimen of medium size, which is more ventricose than 1 *b*, *c*.

Fig. 2 *a*, *b*. Dorsal and profile of a large specimen of elliptical form, preserving a part of the shell in front. This is much less gibbous than usual in specimens of the same size.

Fig. 3 *a*. Cardinal view of a large cast, the ventral valve uppermost.

Fig. 3 *b*. Dorsal view of an individual of ovate form, preserving the greater part of the shell.

Fig. 3 *c*. Cardinal view of a gibbous specimen.

Fig. 3 *d*. Cardinal view of an extremely gibbous specimen, which is flat or slightly concave at the sides, and the centre of the ventral valve strongly elevated.

Fig. 4. A fragment of stone presenting the aspect of these fossils in their usual condition in the rock.

PLATE CV.

Fig. 1. Dorsal valve of a full-grown individual, showing the abrupt inflection at the sides.

Fig. 2. Profile of a large shell in which the parts are pretty well preserved in all their proportions ; the dorsal valve being partially exfoliated, and the striæ not visible.

Fig. 3. Ventral view of the preceding.

Fig. 4. Dorsal view of a large specimen, which is unusually contracted at the sides on the lower half of the shell.

Fig. 5. A partial cast of a ventral valve, showing the form of the muscular impressions and rostral cavity. The forms of the dental plates and teeth are seen on each side, below the beak.

Fig. 6. A partial cast of a dorsal valve, showing a process reaching from the beak to the muscular impressions below. This process is the filling of the foramen, and extends from the cavity of the dorsal valve beneath the bases of the crural supports, coming out at the apex of the beak.

Geological position and localities. In the Oriskany sandstone : Albany, Greene, Ulster, Schoharie, Otsego, Herkimer, Cayuga counties, and at nearly all localities of the Oriskany sandstone in New-York; in Canada East and West, and in Pennsylvania, Maryland and Virginia.

Rensselæria ovalis.

PLATE CVI. FIG. 2 *a* – *l*.

Meganteris ovalis : HALL, Regents' Report for 1856, p. 101; Palæozoic Fossils, 1857, p. 61.

SHELL longitudinally broad-oval, compressed; lateral margins subtruncate and abruptly inflected; front rounded and rarely subangular. Ventral valve slightly the more elevated, most prominent along the middle, sloping gradually towards the sides : beak pointed, arched so as to bring the apex above the hinge-line (in casts), but not touching the opposite valve, angular along the lateral slopes. Dorsal valve regularly depressed-convex : beak incurved.

SURFACE marked by very faint simple radiating striæ, which become obsolete on the upper part of the shell. Shell-structure finely punctate.

Casts and much-worn or exfoliated specimens of this species, only, have come under my observation : none of these have the apex of the beak entire, nor do they show the character of the foramen. It is evidently very near the *R. suessana*, but differs, however, in being larger, more compressed, and often proportionally broader. Casts of this species also resemble those of *Terebratula archiaci* of DE VERNEUIL (DUNKER und VON MEYER, Palæontographica, dritter band, 4, pl. XXVII, f. 2).

Fig. 2 *a*. The ventral valve of a specimen, which partially preserves the shell on the upper part.

Fig. 2 *b*. Another specimen from which the shell is partially removed.

Fig. 2 *c*. Profile of the same, showing the inflected margins of the shell. The specimen has been flattened by pressure.

Fig. 2 *d*. Ventral view of a well-preserved cast of this species.

Fig. 2 *e*. Dorsal view of the same, showing the muscular impression, imprints of the hinge-plates, and the dental plates preserved in the cast of the rostral cavity of the opposite valve.

Fig. 2 *f*. Profile view of the preceding specimen.

Fig. 2 *g*. The upper portion of the preceding specimen enlarged. The indentations on the hinge-line are due to marks sometimes shown on the valves of old specimens of some or all the species of this genus.

Fig. 2 *h*. The cast of a smaller specimen, showing the muscular area and the marks of the adductor muscles.

Fig. 2 *i*, *k*, *l*. Dorsal and ventral views of imperfect casts of this species.

Geological position and locality. In the Oriskany sandstone : Albany and Schoharie counties.

Rensselæria suessana.

PLATE CVII. FIG. 1 – 15.

Meganteris suessana : HALL, Regents' Report for 1856, p. 100; Palæozoic Fossils, 1857, p. 60.

SHELL longitudinally ovate varying to oval or subelliptical, and sometimes the length and breadth equal, somewhat compressed : valves nearly or quite equal; no traces of a sinus on either valve; front narrowly rounded; lateral margins very abruptly inflected. Hinge-line nearly straight or sloping from the beak at a very obtuse angle, much less than the width of the shell. Ventral valve depressed-convex, most prominent along the middle, sloping very gradually towards the sides : beak pointed, small, very angular along its lateral borders, incurved, rising above the hinge-line but not touching the other valve, perforate in the apex by a small round aperture partly completed by the two small deltidial pieces, which, together with the thickened dental apophyses of the opposite valve, often partially close the triangular foramen below. Dorsal valve symmetrically depressed-convex, sloping very gradually from near the middle laterally and towards the front, rounding a little more abruptly towards the beak, which is pointed and scarcely incurved.

SURFACE smooth in silicified specimens; but on well-preserved examples the entire surface is marked by simple radiating striæ, which are almost always preserved in some degree towards the lateral and basal margins of the shell.

Some variety of form occurs among the fossils of this species, in which we find the broad ovate and the symmetrically oval forms as seen in the first two figures on the plate. Another form has a more obtuse beak, and is contracted towards the front, swelling abruptly at the sides, and more gibbous in the middle.

The interior structure has been very well shown in numerous specimens. The ventral valve preserves two strong teeth, with much narrower dental plates than in *R. marylandica*, and which in like manner are shown in the rostral cavity. The muscular area is not strongly defined, and the median septum is scarcely developed. In entire specimens the foramen is neatly rounded; while, in the absence of the deltidial plates, it is a triangular space communicating with the cavity of the shell.

The dorsal valve shows strong hinge-plates which are sometimes much thickened and very prominent, preserving a minute foramen below the apex, which may be closed or communicate with the cavity of the shell below. The crura are strong and round at their bases, becoming abruptly slender, sometimes proceeding directly and sometimes slightly diverging, giving off in one direction the slender points which penetrate the cavity of the ventral valve, and in the other direction bending into the cavity of the dorsal valve, and at the same time spreading laterally. The crural plate is variable in form from broad to very narrow lanceolate, nearly straight or more concave on the upper or rostral side, with a slender process issuing from the centre and directed obliquely upwards into the cavity of the ventral valve. The muscular impression is double and strongly marked in well-preserved specimens; the median septum more or less strongly defined, but in no instance has it been observed to rise so high as the bottom of the crural plate.

Fig. 1. Dorsal view of a specimen of a symmetrically oval form.

Fig. 2. A specimen showing a more prominent beak and contracted front.

Fig. 3 *a*, *b*. Ventral and dorsal views of a specimen of less extreme form than the preceding.

Fig. 4. An elongate form which is more symmetrically oval.

Fig. 5 *a*. Dorsal view of a small specimen of the prevailing or characteristic form.

Fig. 5 *b*. Profile view of the preceding, showing a scarcely perceptible incurving of the valves at their lateral margins.

Fig. 5 *c*. Dorsal view of an older specimen, showing the perfect condition of the shell.

Fig. 5 *d*. Profile view of the same, showing the inflected margins of the shell.

Fig. 5 *e*, *f* & *g*. Dorsal, ventral and profile views of a full-grown specimen of this species.

Fig. 6. A cast of a similar form.

Fig. 7. The interior of two ventral valves, one preserving the deltidial plates and the other without them. The muscular impressions are but feebly preserved.

Fig. 8. The interior of two dorsal valves; one showing the hinge-plates in their usual form, and the upper one having them much thickened: in the latter, the crura diverge at their origin, while in the other they proceed in a longitudinal direction for a short distance before bifurcating.

Fig. 9. The dorsal valve, showing the hinge-plates, dental fossets, foramen, crura and crural plate, and appendages. The figure is slightly enlarged.

Fig. 10. The figure of a similar specimen, where the hinge-plates are much thickened and rounded, the crura branching near their base, and the crural plate narrower than in the preceding.

Fig. 11. A diagram showing a longitudinal section of the two valves in connexion, with the crura and appendages.

Fig. 12, 13, 14 & 15. Figures showing the variety of form of the crural plate, as observed in several individuals of this species.

Geological position and locality. In the Oriskany sandstone: Cumberland, Md.

Rensselæria marylandica (n. s.,.

PLATE CVIII. FIG. 3 *a* – *m*.

SHELL elongato-ovoid, the outline elliptical-ovate, broader above the middle and gently narrowing towards the front, which is sometimes compressed; without mesial sinus or elevation. Ventral valve ventricose, the greatest elevation at the first third from the beak, where it is sometimes subobtusely angular : beak small, incurved over the opposite valve, and sometimes so much incurved as to close the foramen partially or entirely; often, however, showing the deltidial pieces : the lateral margins, in old shells, abruptly inflected. Dorsal valve less convex than the opposite, the greatest gibbosity being at the first third below the beak, sometimes flattened towards the front and abruptly inflected at the lateral margins; leaving, with the inflection of the opposite valve, a flattened or concave space on each side.

SURFACE marked by fine radiating striæ, which, in the silicified specimens, are often scarcely distinguishable on the upper part of the shell.

The interior of the ventral valve shows a deep symmetrical cavity, the muscular impressions occupying a narrow oval space above the middle of the shell. The cardinal teeth are strong, and supported below by strong dental plates, which, on their anterior edges, are separated from the side of the shell, and, about halfway in the depth of the cavity, turn backwards towards the beak, come together in the rostral cavity, and reach into the foramen. From the anterior basal margins of these plates proceed the lamellæ which border the muscular impression, and which gradually become obsolete in the anterior direction : the muscular impression is oblong-subelliptical, and the narrow imprints of the adductor muscles are small and often but faintly defined. There is a medio-longitudinal septum, which is much less strongly marked than the marginal rim. The deltidial pieces are rarely preserved in the separated valves.

The interior of the dorsal valve shows the strong hinge-plates, each with a wide triangular upper surface, and connected by a transverse

process a little below the apex, beneath which a foramen passes from the cavity of the valve, opening at the slightly elevated beak in an oval aperture. The hinge-plates are extended below along the surface of the shell, in strong ridges, which are dichotomized at the beginning of the muscular impression. Anteriorly these plates project in strong crural processes, which are straight only for a short distance, and then diverge in two slender points to the cavity of the ventral valve, in their main direction trending upwards into the dorsal cavity, and then by an abrupt geniculation proceed in a converging direction to the commencement of the crural plate. This plate is extremely elongate and very slender, deeply emarginate behind, with a slender process proceeding from the centre, which, with the two posterior branches, converge towards the bottom of the ventral cavity.

This shell resembles very closely the *R. ovoides*, so abundant in the Oriskany sandstone in New-York, and it is possible that it may be only a variety of that shell. Nevertheless all the specimens seen preserve the characters described, without any indication of gradation to the other form, which likewise occurs, in its large size and more coarsely striated surface, in the sandstone with this one. The details of hinge structure a very clearly shown in several individuals, and the elongate crural plate in a single specimen.

Fig. 3 *a*. Dorsal view of a specimen of this species.

Fig. 3 *b*. Ventral view of the same.

Fig. 3 *c*. Profile or lateral view of the same.

Fig. 3 *d*. Cardinal view of the same, having the ventral side upwards.

Fig. 3 *e*. Front view of another specimen (not well shown in the figure).

Fig. 3 *f*. The apex of the ventral valve (somewhat enlarged), showing the foramen, and the deltidial pieces forming the lower side of the foramen (the outer margins are too thick in the figure).

Fig. 3 *g*. The interior of the ventral valve, showing the teeth, the dental plates, and muscular impression.

Fig. 3 *h*. A similar specimen where the cavity of the valve is not so deep, showing the form of the muscular area and the places of the adductor muscles. The inner edges of the dental plates are seen extending into the cavity of the foramen.

Fig. 3 *i*. The rostral portion of the two valves joined at the hinge : the dorsal valve is downwards, showing the bases of the crural plates and the ridges proceeding from these. The opening of the foramen between the bases of the crural processes is very perceptible.

Fig. 3 *k*. The interior of the upper part of a dorsal valve, showing the broad hinge-plates, the bases of the crura, the elevated median process, and the foramen below the apex.

Fig. 3 *l*. Diagram of the interior of the dorsal valve, showing hinge-plates, dental sockets, apicial foramen, crural processes and crural plate. In the specimen from which this figure is taken, these processes are all encased in crystalline matter, the form and direction of the parts alone being visible. The slender process at the base of the crural plate is broken off; and since its entire length is unknown, the base alone is represented.

Fig. 3 *m*. A diagram representing a longitudinal section of the shell, and the internal apparatus of the two valves when connected.

Geological position and locality. In the Oriskany sandstone : Cumberland, Md.

Rensselæria intermedia (n. s.).

PLATE CVIII. FIG. 2 *a*, *b*, *c*.

SHELL ovate, narrowed towards the front : valves subequally convex, gibbous in the middle and somewhat abruptly declining towards the base and baso-lateral margins, the greatest width a little above the middle, the rostral end the broader. Ventral valve more convex than the opposite, and more elevated along the centre longitudinally in an undefined subangular ridge : beak small and neatly defined, curving over the umbo of the opposite valve, its truncated extremity being parallel to the plane of the longitudinal axis; deltidial plates minute. Dorsal valve regularly convex, the greatest convexity in the middle.

SURFACE marked by fine equal radiating striæ, which are more strongly delineated on the basal and lateral parts of the shell. Concentric lines of growth, at unequal intervals, give the lower half of the shell an imbricated appearance. Internal structure as in the *R. marylandica*.

This species resembles the preceding in its general aspect, but is more ovate, narrowing abruptly towards the front; and the margins of the shell are not inflected to any considerable degree, though the tendency to this condition is sometimes manifest.

Fig. 2 *a*. Dorsal view of a well-preserved specimen.

Fig. 2 *b*, *c*. Profile views of different individuals of the same species.

Geological position and locality. In the Oriskany sandstone : Cumberland, Md.

Rensselæria cumberlandiæ.

PLATE CVIII. FIG. 1 *a* – *e*.

Meganteris cumberlandiæ : HALL, Regents' Report for 1856, p. 101; Palæozoic Fossils, 1857, p. 61.

SHELL elliptical : valves nearly equal, somewhat acutely rounded in front; no trace of a sinus in either valve; lateral margins abruptly inflected. Ventral valve rounded and most convex along the middle, sometimes becoming angular towards the beak, sloping laterally and forming a broad semielliptical curve from front to beak, a little more gibbous above than below the centre : beak prominent, slightly arched; foramen terminal, small when the deltidial pieces are present, large and triangular when these pieces are removed. Dorsal valve depressed-convex, a little smaller than the other : beak scarcely incurved.

SURFACE apparently smooth, or marked by obscure concentric lines and faint wrinkles of growth, and, near the margin, by strong radiating striæ.

This is a very distinct species, and may be distinguished from *R. suessana*, some varieties of which it most resembles, by its more elongate form and the more prominent beak of the ventral valve : the cardinal margin of the ventral valve, on each side of the beak, is also more extended, and the margins of the valves are never so abruptly incurved. Some specimens, from interrupted growth, present a thickened imbricating lateral and frontal margin.

Fig. 1 *a*, *b*, *c*. Ventral, dorsal and profile views of an entire specimen.

Fig. 1 *d*, *e*, *f*. Ventral, dorsal and profile views of an imperfect specimen, the dorsal view showing the triangular foramen which results from the removal of the deltidial plates. (These three figures were placed upon the stone before perfect specimens were obtained.)

Geological position and locality. In the Oriskany sandstone : Cumberland, Md.

LAMELLIBRANCHIATA OF THE ORISKANY SANDSTONE.

The lamellibranchiate shells of this rock comprise few species, and these usually occur in such condition as to afford very unsatisfactory means of determination; the specimens being for the most part in the form of casts of the interior, or impressions of the exterior of the shell.

Avicula textilis, var. arenaria.

Plate CIX. Fig. 1 & 2; and Plate CX. Fig. 2.

Avicula textilis : This volume, page 288.

Shell large, obliquely subovate; the proportions of length and height variable. Left valve becoming moderately and regularly convex from the base, the greatest convexity being about the first third below the hinge-line. Posterior wing large, extending along the margin of the body of the shell halfway from beak to base. Anterior wing small, triangular, wrinkled. The right valve is slightly concave, smaller than the other, faintly marked by the radiating ribs, which sometimes are scarcely seen.

Surface marked by strong radiating ribs sometimes regularly dichotomizing and subequal, and in other specimens quite unequal, showing a few stronger ribs with several finer ones between, and these are crossed by strongly elevated imbricating lamellæ.

This is the common form of *Avicula* in the Oriskany sandstone, and often attains a height of four inches or more. Although presenting considerable variety in its aspect and surface markings, I am unable at the present time to point out reliable specific distinctions between this one and the species of the Lower Helderberg limestones.

PLATE CIX.

Fig. 1. An impression made in sandstone by the exterior surface of the smaller or right valve.

Fig. 2. The exterior imprint of the left valve of this species.

PLATE CX.

Fig. 2. The exterior surface of a weathered and exfoliated specimen of the left valve.

Geological position and locality. In the Oriskany sandstone : Albany and Schoharie counties (New-York), and Cumberland (Maryland).

Avicula recticosta (n. s.).

PLATE CIX. FIG. 3.

SHELL slightly oblique, subrhomboidal : hinge-line greater than the greatest width of the shell below; width equal to about once and a third the height, very moderately convex. Posterior wing large, extending nearly as far backwards as the posterior margin of the shell. Anterior wing smaller, triangular, slightly concave on the outside.

SURFACE marked by strong dichotomizing subequal ribs, which proceed principally in pairs from the umbo to the margin of the shell. Posterior wing with fine radiating ribs and close concentric laminæ; the anterior wing being marked only by the concentric striæ.

A single specimen of this species only has been observed, but its form and proportions indicate its distinction from the preceding.

Geological position and locality. In the Oriskany sandstone : Helderberg mountains.

Avicula gebhardi.

PLATE CX. FIG. 1 *a*, *b*; and PLATE CXI. FIG. 2.

Avicula gebhardi : CONRAD, Annual Report on the Palæontology of New-York, 1841, p. 54.

SHELL "suborbicular : left valve convex, with about fifteen slightly im-
" pressed radiating grooves, forming wide convex obsolete ribs; ears
" equal, not produced. Height about five inches."

The original specimen, from which Mr. CONRAD made his description, is figured on Plate CXI.

PLATE CX.

Fig. 1 *a*. A cast of the left valve of a specimen.

Fig. 1 *b*. A smaller specimen, in which the ribs are better preserved.

PLATE CXI.

The cast of the left valve of a large individual of this species.

Geological position and locality. In the Oriskany sandstone : Albany and Schoharie counties.

Megambonia bellistriata (n. s.).

PLATE CIX. FIG. 4.

SHELL obliquely ovate, symmetrically convex, regularly rounded below, and gradually narrowing above. Anterior wing large, convex.

SURFACE marked by fine subequal rounded or somewhat flattened striæ, which are wider than the spaces between them, increasing by interstitial additions, and finely crenulated by concentric striæ. The radiating ribs on the wing are coarser than on the body of the shell, and the concentric striæ become lamellose.

The specimen is a mould, in sandstone, of the left valve, and the figure is drawn from a cast made in this mould. The wing is convex, like those of the genus generally, and the hinge-line and posterior slope are unknown.

Fig. 4. A cast of the left valve, from a mould of the exterior in sandstone.

Another specimen, which is a distorted cast of the interior of an individual, apparently of this species, shows faint radiating striæ and a long posterior slope, without defined wing.

Geological position and locality. In the Oriskany sandstone : Albany and Schoharie counties.

Megambonia lamellosa (n. s.).

PLATE CIX. FIG. 5 & 6.

SHELL obliquely ovoid, very gibbous in the middle and towards the umbo; the body of the shell rather abruptly narrowed above the middle. Anterior wing short, rounded, very convex, separated from the body of the shell by a broad rounded depression, leaving a sinus in the margin. Posterior wing broad triangular, extending more than two-thirds the entire length of the posterior slope; its junction with the body of the shell marked by a depression.

SURFACE marked by concentric lamellose striæ, which, on some parts of the specimens, are very prominent. Faint remains of radiating striæ are sometimes perceptible on the casts.

Fig. 5. The left valve of a specimen of this species.

Fig. 6. The left valve, showing a proportionally more extended wing than the preceding.

Geological position and locality. In the Oriskany sandstone : Albany and Schoharie counties; and at Oriskany falls, Oneida county, New-York.

In general features, and in generic characters, the Gasteropoda of the Oriskany sandstone do not differ from those of the Helderberg limestones. The prevailing forms in the sandstone in New-York are *Platyostoma ventricosa* and *Platyceras nodosum*, while *Strophostylus expansus* is very rarely seen. In the same rock in Maryland and Virginia the first of these species is comparatively rare, while the two last have not been observed: at the same time, these southern localities have furnished three other species of *Strophostylus*. The *Platyceras gebhardi*, known only in the Helderberg limestones in New-York, is found in the Oriskany sandstone in Maryland and Virginia, associated with several other species of the same genus, some of which occur in great numbers.

While in New-York the rock is of such a character that the shells of these fossils are not preserved, and we have simply the casts of the interior, in Maryland and Virginia they occur as silicified shells, the silica having entirely or almost entirely replaced the calcareous matter; and the fragile forms are free from adhering stone, with aperture, peristome, and the cavity of the shell as distinctly seen as in living species. This unusual of the fossils condition enables us to determine more accurately the characters of some of these forms, than could have been done from all the other palæozoic collections.

The great number of specimens examined has shown, even in the same species of *Platyceras*, a wide variation in certain characters. While in some examples the peristome is quite free and the aperture symmetrical, in others the peristome is closely joined to the body volution, and even sometimes recurved so as to form a columella, leaving a wide umbilicus; characters which are incompatible with the genus as originally described. At the same time, in several examples observed of *Strophostylus*, the peristome is almost entirely free; and in some specimens of *Platyostoma* there is a close approach to *Platyceras* on the one hand, while, in th

incipient tortuous columella, one or two specimens approach the Genus *Strophostylus*.

Although the discrimination of species is attended with some difficulty when few specimens are examined, there has nevertheless appeared, in the large collections obtained, sufficient reason to regard the species indicated as well established.

Platyostoma ventricosa.

PLATE CXII. FIG. 1 – 10; PLATE CXIII. FIG. 7 & 8; and PLATE CXV. FIG. 8.

Platyostoma ventricosa : CONRAD, Jour. Acad. Nat. Sci. Philadelphia, Vol. viii, pa. 275, pl. 17, f. 1.
— — This volume, pa. 300, pl. 55.

SHELL globose or depressed-globose and often obliquely ovoid, varying in form. Spire moderately elevated, consisting of three or four volutions, the last of which is extremely ventricose : volutions flattened upon the upper side; aperture circular or subovate; columellar lip reflexed.

SURFACE marked by fine closely arranged striæ parallel to the lines of growth.

The surface is sometimes marked by broad undulations, both in young and in old shells; but I am not able to find in these forms any means of specific distinction.

PLATE CXII.

Fig. 1 & 2. Young shells of this species.

Fig. 3. A young specimen, showing a broad undulating surface.

Fig. 4 *a*. View of the aperture of the same.

Fig. 4 *b*. An older specimen of the ordinary form.

Fig. 5 *a*, *b*. View of the spire, and of the aperture of a specimen of medium size.

Fig. 5 *c*. Profile of a specimen which is somewhat depressed vertically.

Fig. 6. A young specimen with a more elevated spire. This is of the type of *P. arenosa* of CONRAD (See page 302, this volume).

Fig. 7 & 8. View of the spires of two specimens of ordinary form.

Fig. 9. A specimen which has been vertically compressed.

Fig. 10 *a*, *b*. View of a specimen which is a little compressed obliquely.

PLATE CXIII.

Fig. 7. Profile of the spire of a very large specimen, which has been somewhat compressed vertically.

Fig. 8. View of the spire of the same specimen. The surface shows broad undulations parallel to the lines of growth.

In another specimen of less size than fig. 8, which has been compressed in a direction parallel to the vertical axis, the height of the spire is nearly twice as great as in the one figured.

PLATE CXV.

Fig. 8. A fragment of a specimen, apparently of this species, preserving a little more than one volution and a part of the aperture, with the pillar-lip, which is thickened and smooth.

Geological position and localities. In the Oriskany sandstone : Albany, Schoharie, Greene and Ulster counties, and elsewhere in New-York; and in the same rock in Maryland and Virginia.

Strophostylus transversus (n. s.).

PLATE CXIV. FIG. 1 *a*, *b*, *c*.

SHELL obliquely ovate, symmetrical. Spire little elevated : volutions about four, the last one extremely ventricose and very much extended on the margin; aperture subcircular; outer lip very thin, curving downwards and spreading over the surface of the adjacent volution. Columellar lip spirally grooved : suture canaliculate.

SURFACE finely striated in direction parallel to the lines of growth, with a few more strongly marked imbricating lines of growth.

This species is remarkable for the great lateral extension of the last volution in the aperture : the spire is very neatly tapering, and of little bulk beyond the first volution. In the specimen figured, the greatest height of the aperture is equal to its greatest width from the columellar lip; its oval appearance in the figure being due to turning the shell so as to bring the spire into view, which is not seen when looking directly into the aperture.

Fig. 1 *a*. View of the spire, with the aperture placed horizontally.

Fig. 1 *b*. View of the aperture, which is narrowed by turning the upper margin forward.

Fig. 1 *c*. Profile view of the shell from the upper side.

Geological position and locality. In the Oriskany sandstone : Cumberland, Md.

Strophostylus expansus.

PLATE CXIV. FIG. 2 & 3 *a*, *b*.

Platyceras expansus : CONRAD, Annual Report on the Palæontology of New-York for 1841, p. 55.

SHELL "dilated, suborbicular : spire small, not prominent, with three "volutions; aperture profoundly dilated; labrum angulated."

The above description I suppose to indicate this species, it being the only one known to me in the Oriskany sandstone to which it is applicable. The shell is large, obliquely subovate, preserving in the cast but two volutions, a third having doubtless existed in the entire shell. The spire, beyond the first volution, is extremely small; suture canaliculate : the aperture is nearly circular (in a specimen somewhat compressed); the columellar lip, on its outer margin, is strongly angulated, and concave within. The aperture is filled with stone, so that the inner edge of the pillar lip cannot be seen.

This species is more expanded than the preceding, with a proportionally smaller spire beyond the first volution.

Fig, 2. A small specimen which is obliquely compressed. The peristome is extended around the adjacent volution, giving it a different aspect from the other specimens of the same species.

Fig. 3 *a*. View of the aperture, showing its form, with the outer angle of the columellar lip.

Fig. 3 *b*. View of the upper side of the spire and the expanded body volution.

Geological position and locality. In the Oriskany sandstone : Albany and Schoharie counties.

Strophostylus matheri (n. s.).

PLATE CXVIII. FIG. 1 *a*, *b*.

SHELL obliquely ovoid or subglobose; the spire elevated : volutions about four, the last comprising almost the entire bulk of the shell. Aperture subcircular, a little higher than wide : peristome continuous, thin, joining the adjacent volution on the lower side or becoming free on the posterior side, and joining the outer margin of the columellar lip. Volutions very symmetrically decreasing : suture canaliculate; the depression deepening towards the last volution, till, in older forms, the last volution is sometimes quite free at the aperture.

SURFACE marked by fine transverse striæ, which, in older specimens, become towards the aperture elevated, lamellose, and imbricating.

This differs from either of the above described species, in its more elevated spire and the great height of the aperture, as well as the expansion of the peristome over the preceding volution, and the disjoining of this part in old shells.

The specimen figured is imperfect, but presents in a pretty satisfactory manner the principal features of the species. Another specimen, of larger size, has an aperture of one inch and a quarter in height.

Fig. 1 *a*. Profile view of the spire.

Fig. 1 *b*. View of the aperture, which is imperfect in outline, the columellar side being broken off.

Geological position and locality. In the Oriskany sandstone : Cumberland, Md.

Strophostylus andrewsi (n. s.).

PLATE CXVIII. FIG. 2.

SHELL somewhat semiovoid. Spire very slightly elevated above the last volution, which is extremely ventricose : aperture subcircular, a little higher than wide; peristome very oblique to the axis of the shell, expanding over the inner side of the previous volution, but not continuous with the outer edge of the columellar lip, which is angular, the lip short, and terminating abruptly below.

SURFACE marked by fine equal striæ.

This species differs conspicuously in its low spire, broader aperture, and short abruptly terminating pillar-lip, from either of the species in this rock.

Fig. 2. View of the aperture, columellar lip, etc.

The figure does not represent the aperture sufficiently circular or high.

Geological position and locality. In the Oriskany sandstone : Cumberland, Md.

Platyceras tortuosum (n. s.).

PLATE CXIII. FIG. 1 – 5.

SHELL spirally ascending, making a little more than one free volution : volutions widely separated, very gradually increasing in size towards the aperture, which is scarcely expanded; peristome very oblique. A broad spiral fold sometimes marks the inner side of the spire.

SURFACE unknown.

The specimens are all casts, or preserve a very small portion of the shell, which is not sufficiently perfect to show the surface characters.

This species is closely allied to *P. spirale*, but does not appear to have had a contiguous volution at the apex, nor to be so distinctly spirally plicate; while the specimens show no marked expansion at the aperture.

Fig. 1 – 5. Views of different individuals (which are more or less perfect), showing a gradation in size.

Geological position and locality. In the Oriskany sandstone : Albany and Schoharie counties.

Platyceras ?

PLATE CXIII. FIG. 6.

The specimen is a cast, too imperfect for determination; from the sandstone at Schoharie.

Platyceras nodosum.

PLATE CXV. FIG. 1 – 6; and PLATE CXVI. FIG. 1 – 4.

Platyceras nodosus : CONRAD, Annual Report on the Palæontology of New-York for 1841, p. 56.

"Subfalcate, with numerous thick obtuse nodes. This is a cast in sand-
" stone, and the shell was probably covered with spines. Length two
" inches."

The above description appears to have been drawn from a cast in which the first volutions are wanting; a common condition of the specimens in the sandstone.

SHELL obliquely subovate : volutions contiguous, about two or three, very rapidly expanding from the apex; summit of the spire on a plane with, or a little above, the outer volution; aperture round.

SURFACE marked by round obtuse nodes and strong interrupted or tortuous lamellose striæ.

All the specimens observed are casts, with sometimes the impressions of the exterior. The nodes indicate the places of short strong spines on the surface of the shell. In nearly all the larger specimens the apex is broken off, so that a single volution or less is preserved.

PLATE CXV.

Fig. 1 *a*, *b*, & 2. Young specimens of this species, preserving about two volutions.

Fig. 3 *a*, *b*, *c*. A young specimen which preserves the proper form of the shell.

Fig. 4. A larger individual.

Fig. 5. A larger specimen, preserving little more than a single volution.

Fig. 6. A larger specimen of similar character with the preceding.

It is not improbable that the apex or first volutions become solidified as the shell advances in age, leaving no evidence of the existence of these parts in the cast.

PLATE CXVI.

Fig. 1 & 2. Casts of this species, preserving the usual form.

Fig. 3 & 4. View of the upper and lower side of the cast of a large individual. In this specimen, the nodes, either from weathering or extreme age and thickening of the shell, are less prominent than in the preceding.

Geological position and locality. In the Oriskany sandstone : Albany and Schoharie counties, and numerous other places in the State of New-York.

Platyceras subnodosum (n. s.).

PLATE CXV. FIG. 7.

SHELL spiral, consisting of about a single volution which is nearly in the same plane : volution rapidly expanding from the apex, and somewhat quadrangular, being flattened on the sides and back, with an obscure row of subdued nodes along each angle.

The specimen is a cast, preserving in one part an impression of the shell, which is transversely striate, with the striæ undulating or tortuous at the nodes.

This species is quite distinct from the preceding, in form of volution, arrangement of nodes, etc.

Fig. 7. View of the upper side of the spire.

Geological position and locality. In the Oriskany sandstone : Schoharie county.

Platyceras gebhardi.

PLATE CXVII. FIG. 1 – 10.

Platyceras gebhardi : CONRAD. See page 312 of this volume.

The specimens figured on Plate CXVII were obtained several years after the figures on Plate LVI had been engraved, and serve to establish more fully the character of the species, as well as to prove its existence in the Oriskany sandstone.

The specimens of this series are very interesting; showing some forms where the peristome is free, and others where it is spread over the convexity and adhering to the preceding volution, even so far as to be recurved; forming in fact a columellar lip, and leaving a distinct umbilicus as shown in figures 1, 2, 4 & 5. In a single specimen of large size, not figured, the peristome adheres to the volution, and the convexity of the latter is shown projecting within the otherwise symmetrical aperture. In another specimen of medium size, the peristome is so closely incorporated with the adjacent volution as to leave only a callosity on the lower half; while below the volution the peristome is a little recurved, and the shell deeply umbilicate. In this specimen, the continuity of the peristome would hardly be suspected or observed.

Fig. 1 *a*, *b*. A young shell, in which the peristome is closely adhering to the body whorl.
Fig. 2. A similar specimen with the preceding.
Fig. 3 *a*, *b*. A larger individual of the same character.

Fig. 4. A specimen where the peristome is more expanded.

Fig. 5 *a*, *b*. A specimen in which the peristome is free and not expanded.

Fig. 6 *a*, *b*. A larger specimen, in which the peristome is expanded and free.

Fig. 7, 8 & 9. Specimens in which the peristome is not expanded, or but slightly expanded and essentially free.

Fig. 10 *a*, *b*. Two views of a large specimen with a free peristome and small umbilicus.

Fig. 10 *c*. A specimen with expanded aperture, the peristome adjacent to the body volution, but still free. The umbilicus is much larger than in the preceding specimen.

The three last figures present nearly the maximum of size observed among the specimens from the Oriskany sandstone in Maryland, and it has not been seen in the same position in New-York.

Geological position and locality. In the Oriskany sandstone : Cumberland, Md.

Platyceras ventricosum.

PLATE CXVIII. FIG. 3 – 9.

Platyceras ventricosum : CONRAD. See page 311 of this volume.

To the description already given, may be added :

Volutions contiguous throughout, or the last one free ; peristome continuous or interrupted, free or in contact with the body volution, sometimes abruptly expanded at the margin.

The surface markings are rarely preserved in any considerable degree of perfection in the silicified specimens.

Fig. 3 *a*, *b*. Views of a young specimen in which the peristome is not continuous ; the body whorl encroaching on the aperture, with an attenuated film of the labrum covering it, the lower side curving into the umbilicus, and the margin below the volution reflexed nearly parallel with the axis. In the figure, the labrum is too distinctly shown upon the body volution.

Fig. 4 & 5. Views of a small specimen of the usual form, with a widely expanded aperture. The peristome is only slightly sinuate from the encroachment of the body volution.

Fig. 6 *a*, *b*. Views of a specimen above the medium size, where the volutions are in contact, the peristome free and moderately expanded.

Fig. 7 *a*. A larger specimen in which the peristome is continuous, but joined to the body volution and abruptly deflected below, giving the appearance of a columellar lip. The figure represents very imperfectly the extent of the sinuosity and the form of the lip below the volution.

Fig. 7 *b*. The upper side of the spire of the same specimen, showing a broad shallow sinuosity in the margin.

Fig. 8 *a*, *b*. Views of the aperture and of the spire of a large individual, where the last volution is free, and the peristome continuous and somewhat expanded on the left side.

Fig. 9 *a*, *b*. The aperture and lower side of a large specimen, where the volutions are contiguous, the umbilicus is very small, and the peristome continuous; the outline slightly sinuate just below the body volution, and expanded upon that side.

Geological position and locality. In the Oriskany sandstone : Cumberland, Md.

Platyceras magnificum (n. s.).

PLATE CXIX. FIG. 1 – 6.

SHELL obliquely subovate. Spire depressed below the plane of the outer volution : volutions two or three, very rapidly expanding and becoming extremely ventricose below, usually free or with the first one contiguous; aperture expanded, subcircular, campanulate, and often with the margin reflexed, particularly on the left side.

SURFACE marked by distinct transverse lamellose undulating striæ.

This species has some resemblance to *P. ventricosum*, but differs in its more rapidly attenuating spire and the freedom of the volutions, as well as the comparatively greater expansion of the aperture. In some of the specimens the surface shows undulations in the striæ, indicating the former existence of sinuosities in the margin of the shell; but such features are rarely seen, or scarcely visible in the peristome of the specimens examined.

Fig. 1 *a*, *b*. View of the spire and aperture of a young shell. (The volutions are actually free to the apex, although not distinctly represented in the figure.)

Fig. 2 *a*, *b*. A larger specimen with free volutions, having the aperture abruptly expanded.

Fig. 4 *a*, *b*. A larger specimen, with the volutions free and the peristome less expanded.

Fig. 5 *a*, *b*. A larger specimen, having the apex broken off. This specimen presents a sinuosity in the posterior side of the aperture.

Fig. 6 *a*, *b*. View of the aperture and spire of a large specimen in which all the parts are symmetrical and well preserved, and the volutions are free except at the extreme apex. This figure is represented as of the natural size; the extreme length being three inches and three-fourths, while the aperture is two inches and three-eighths in height, and a little more than two inches and a half in length.

Geological position and locality. In the Oriskany sandstone : Cumberland, Md.

Platyceras patulum (n. s.).

PLATE CXIX. FIG. 3.

SHELL subhemispheric. Spire forming about three volutions, which are usually contiguous, sometimes free, very rapidly expanding, the last one extremely ventricose and assuming a hemispheric form; apex much below the plane of the last volution. Aperture nearly circular; peristome much expanded upon the side of the body volution, and thickening below in the form of a columellar lip.

SURFACE transversely striated.

The aperture is proportionally larger than in any other species examined; its height being greater than the length, which is more than two-thirds of the length of the entire shell. When the specimens are laid upon the table with the mouth downward, the height to the summit of the volution is half as great as the longest diameter of the aperture.

Fig. 3. View of the aperture where the peristome is spread over the body volution, and thickened below.

Geological position and locality. In the Oriskany sandstone : Cumberland, Md.

Platyceras reflexum (n. s.).

PLATE CXX. FIG. 1 – 7.

SHELL spiral, obliquely or arcuately subconical, spirally ascending; the apex consisting of one or two free, but closely approximating volutions; the body volution diverging, and spreading somewhat rapidly towards the aperture : aperture broad, the peristome often sinuous and sometimes abruptly expanded : volutions round or subangular, and rarely distinctly angular, with the aperture subquadrate.

SURFACE transversely striate; the striæ sometimes bent abruptly backwards on the surface, indicating the existence of a marginal notch at some period of growth.

This species bears some resemblance to *P. spirale* of the Shaly limestone, but is a more robust shell, and has not the spiral ridges upon the surface, besides attaining a much larger size.

Fig. 1 *a*, *b*. View of the upper side of the spire, and of the aperture of a small specimen.

Fig. 2 *a*, *b*. Similar views of a shorter form of the same species.

Fig. 3. A larger specimen of the same species.

Fig. 4. A specimen in which the first volution of the spire is concealed. The surface shows some obscure marks of spiral plications.

Fig. 5. A large specimen in which the last volution is more than usually deflected, standing almost at a right angle with the preceding volution.

Fig. 6 *a*, *b*. Two views of a specimen in which the aperture is obtusely quadrangular.

Fig. 7 *a*, *b*. A similar specimen to the preceding, where the last volution is less deflected than usual from the direction of the preceding volutions.

The figures given were intended to be representations of the principal varieties of form presented by this species.

Geological position and locality. In the Oriskany sandstone : Cumberland, Md.

Platyceras? (Platyostoma?) callosum (n. s.).

PLATE CXX. FIG. 8 *a*, *b*.

SHELL obliquely ovoid, ventricose. Spire consisting of about three volutions; the apex minute, and the first two volutions nearly in the same plane; the last volution expanding greatly below. Aperture suborbicular (imperfect in the specimen): peristome continuous, thickened and coalescing with the body volution at its lower side; the umbilical cavity closed by a callosity; the shell, approaching the aperture, becoming lamellose; the lamellæ elevated and imbricating.

SURFACE marked by undulating transverse striæ and by obscure revolving striæ, with obsolete parallel undulations. The lines of growth are strongly arched forward on the middle of the back of the shell.

The specimen figured is the only one of the species observed, and, in its characteristic features, is a departure from the typical forms of PLATYCERAS in the expansion of the peristome and its incorporation with the adjacent body volution, forming a thickened callosity, and below this a reflected and thickened pillar lip. Taking the lower half of the aperture, it preserves the character of PLATYOSTOMA, but is wanting in an important character shown in the typical species, viz. the joining of the peristome with the body volution near the upper part of the spire; while the columellar lip is irregularly thickened and lamellose.

Fig. 8 *a*. View of the back and upper part of the last volution.

Fig. 8 *b*. View of the aperture, spire, and callosity of the columellar lip.

Geological position and locality. In the Oriskany sandstone : Cumberland, Md.

Cyrtolites? expansus (n. s.).

PLATE CXIV. FIG. 4 & 5.

SHELL obliquely depressed-conical; the apex incurved, but making scarcely, or no more than, a single volution, very rapidly expanding from the apex; the body ventricose, subcarinate on the dorsum : aperture nearly circular.

SURFACE of cast marked by faint transverse ridges and finer longitudinal striæ.

I have seen but two specimens of this fossil, the smaller of which is more angular in outline, and the dorsal carination stronger; while there are distinct indications of two sets of surface markings, the annulations being stronger towards the apex. The larger specimen shows no marks of striæ, but is contracted near the aperture. The smaller specimen has the aspect of *Cyrtolites ornatus* of CONRAD, but is a broader and less convoluted shell : the determination, however, is by no means satisfactory.

Fig. 4 *a*, *b*. Anterior and lateral views of the smaller specimen.
Fig. 5 *a*, *b*. Anterior and lateral views of the larger specimen.

Geological position and localities. In the Oriskany sandstone : Albany and Schoharie counties.

PTEROPODA [?].

Conularia lata.

PLATE CXI. FIG. 1; and PLATE LXX A. FIG. 3 *a*, *b*.

SHELL elongate, extremely broad : sides slightly convex; angles rounded, not deeply sulcate, without sulcation on the middle of the sides; transverse ridges curving into the sulci of the angles, and directed gently downwards to the middle of each side, where they bend upwards at a very obtuse angle : ridges crested by rounded or transversely elongated nodes or pustules, which are sometimes punctured at their extremities. Longitudinal striæ not determinable, except upon the angles.

The transverse ridges are usually from six to eight in the space of three lines; but they are often, for short distances, much more closely crowded. The pustules are less than half as distant from each other as the space between the ridges.

The specimen figured on Plate CXI is an impression of the exterior of the shell. Another fragment, of four inches in length on one of the angles, has been seen, and one or two smaller fragments of other individuals. It is, however, comparatively a rare fossil.

PLATE CXI.

Fig. 1. A fragment preserving the impression of parts of two sides : the extreme length of one side, which is imperfect both above and below, is five inches.

PLATE LXX A.

Fig. 8 *a*, *b*. A figure from a cast made in the mould of the shell represented on Plate CXI, and the same enlarged.

Geological position and locality. In the Oriskany sandstone : Schoharie and the Helderberg.

Conularia —— ?

I have seen, in the collection of Mr. WHITFIELD, a small fragment, the apex of a species of *Conularia* from the Oriskany sandstone : the surface is partially exfoliated; the transverse ridges are thin and sharp, scarcely preserving the granulose crest. It resembles the *C. huntiana* of the Lower Helderberg limestones.

CEPHALOPODA.

A single species of *Orthoceras* has been found in the Oriskany sandstone and, with this exception, I am not aware of the occurrence of any c phalopodous shells; none having been observed in my collections fr New-York, Maryland or Virginia.

Orthoceras arenosum (n. s.).

SHELL cylindrical, gradually tapering, abruptly annulated; annul distant about one-third the diameter of the shell. Surface unkn The specimen is a fragment several inches in length, attached to a mas sandstone containing several characteristic fossils of the rock.

Geological position and locality. In the Oriskany sandstone : Schoharie

ADDENDA.

Orthis strophomenoides.

PLATE XXIII. FIG. 7 *a*, *b*, *d*, *f*, *g*.

For explanation of these figures, which illustrate more completely the character of the species, see explanation accompanying Plate xxiii, volume of plates.

Orthis cumberlandia (n. s.).

PLATE XCV A. FIG. 20 & 21.

SHELL large, suborbicular, depressed. Ventral valve depressed convex in the middle and towards the beak, flattened or scarcely concave towards the front : area narrow and short; foramen large; dental lamellæ thin; muscular area broadly flabelliform.

The surface externally marked by numerous fine sharp striæ, which are increased by interstitial additions.

This species approaches the *O. tubulostriata* in many of its characteristics, but is sufficiently distinct to be easily identified, the striæ being finer and the beak less prominent. It has the form of muscular impression common to *O. oblata* and others, while it is a thinner shell with more prominent striæ.

Fig. 20. The exterior of a ventral valve of this species.

Fig. 21. The interior of a smaller ventral valve of the same.

Geological position and locality. In the Oriskany sandstone : Cumberland, Md.

Strophodonta intermedia (n. s.).

PLATE XCV A. FIG. 13 & 14.

SHELL semioval. Dorsal valve depressed-convex: hinge-line equalling the greatest width of the shell; cardinal process duplicate, each branch deeply grooved on the rostral side; lamellæ thin and curving, and leaving between them and the hinge-line deep pits for the reception of the dental lamellæ; muscular impressions somewhat broadly flabelliform, and divided by a short low mesial septum.

SURFACE marked by fine rounded radiating striæ, which are increased by the interstitial addition of very slender sharp striæ at intervals between the beak and margin of the shell. Many of the striæ curve upwards, and run out upon the hinge-line.

Fig. 13. The exterior of the dorsal valve.
Fig. 14. The interior of the same.

Geological position and locality. In the Oriskany sandstone: Cumberland, Md.

Strophodonta magnifica,

PLATE XCV A. FIG. 15 – 19,

For description and references, see pages 414 and 415.

Fig. 15. A dorsal view, showing the area, which is imperforate and striate. The spec
below the medium size which this shell usually attains.

Fig. 16. Ventral view of the same: the margins are broken, and the outline is cons
imperfect.

Fig. 17. The interior of a ventral valve of the same species, showing a central pit o

Fig. 18. View of the area when the linear foramen is closed.

Fig. 19. Enlargement of the striæ, showing their mode of bifurcation, and the p
are very regularly interposed between the striæ.

Strophodonta geniculata.

PLATE XXIII. FIG. 6 *a*, *b*, *c*.

SHELL somewhat semicircular, abruptly geniculate towards the base. Dorsal valve flat for two-thirds the length of the shell, when it is abruptly inflected. Ventral valve with a narrow area, the beak projecting a little beyond the opposite, slightly convex from the beak towards the middle, becoming flattened and concave, and the last third abruptly deflected, corresponding with the opposite valve.

SURFACE, at and near the beaks, marked by strong radiating striæ, which bifurcate, and are increased by interstitial additions towards the base of the shell. Tubular openings are noticed at intervals on the summits of the stronger striæ, and round or oval pores mark the interstitial spaces.

In some specimens, the centre of the dorsal valve is marked by a strong sinus with a prominent elevation on each side, with a corresponding mesial elevation on the centre of the opposite or concave valve, and a sinuosity on either side.

Fig. 6 *a*, *b*. Ventral and dorsal views of a specimen of medium or small size.
Fig. 6 *c*. Profile view of the same.

Geological position and locality. In the limestones of the age of the Lower Helderberg group : Cumberland, Maryland.

RHYNCHOSPIRA.

A farther examination of the fossils designated in the volume as a subgenus of TREMATOSPIRA, has convinced me of the propriety of separating them as a distinct genus, which has already been thus published in the Regents' Report on the State Cabinet of Natural History for 1858, p. 29.

GENUS RHYNCHOSPIRA (HALL).

[Gr. ρυγχος, *rostrum*; σπειρα, *spira*; in allusion to its similarity in form to RHYNCHONELLA, and having internal spires.]

Terebratula and *Rhynchonella* of authors.
Waldheimia : HALL, 1856.
Trematospira, Subgenus *Rhynchospira* : HALL, 1857.
Rhynchospira : HALL, 1858.

SHELL longitudinally ovate or subglobose, more or less gibbous, acute at the apex. Valves subequally convex; mesial fold not strongly defined, one, two, or more smaller plications usually marking the centre of each valve : beak of the ventral valve perforate, the perforation generally well defined, the lower side formed by a deltidium which separates it from the umbo of the opposite valve.

SURFACE radiatingly plicate or striate : shell-structure fibrous or fibro-punctate?

VALVES articulating by teeth and sockets; the crura supporting two conical spires, which occupy the greater part of the cavity of the two valves. The cardinal process of the dorsal valve is a broad subemarginate plate, spreading laterally and a little recurved at its basal margins, where it is clasped by the teeth of the opposite valve, and extends beneath the deltidium, lying close against the inner surface of that part of the ventral valve.

The mode of articulation, as now determined, is very similar to that of NUCLEOSPIRA; but the cardinal process is proportionally shorter and emarginate at the extremity, the perforation of the beak large and distinct, while the form is different and the exterior surface plicate or striate, and not punctate as in that genus.

The form of the species is not unlike *Rhynchonella*, but usually more symmetrically rounded, and with less distinct mesial sinuosities. In these characters they resemble WALDHEIMIA, to which genus I had originally referred them until the discovery of the internal spires.

Several of these shells bear a close resemblance, both in the general form and in the interior spires, to RETZIA; but the dorsal valve never presents the straight extended hinge-line, nor the ventral valve the short area, common to the carboniferous species of that genus.

From the external character of the species referred by me to *Atrypa aprinis*, Palæont. New-York, Vol. ii, pa. 280, pl. 57, f. 7 (= *Terebratula aprinis*, M. V. K. Geol. Russia and the Ural Mountains, Vol. ii, pa. 90, pl. x, f. 10), I infer that it belongs to this genus, and the name *Rhynchospira apriniformis* may be adopted for it, since the American and European forms are probably distinct.

Rhynchospira formosa.

PLATE XCV A. FIG. 7 – 11.

Fig. 7. Interior of the ventral valve of *Rhynchospira formosa.*

Fig. 8. Interior of the dorsal valve, enlarged two diameters, to show the broad cardinal process (*j*), which covers the extremity of the beak, and, when the valves are closed, passes beneath the deltidial area of the opposite valve. The bases of the crura (*c*) are shown on each side at the base of the cardinal process, and the short median septum is shown at *s*.

Fig. 9. Profile view of the same, showing the cardinal and crural processes.

Fig. 10. The upper part of the two valves connected in their natural relations to each other, and showing the manner of articulation.

Fig. 11. A longitudinal section, showing the foramen, the deltidium, and the cardinal process of the opposite valve lying beneath it; the crura first bending downwards, and then recurved into the dorsal valve and its continuation in the spire, with the descending process *e*, which forms, with the opposite one, a connecting filament between the two spires.

Rhynchospira rectirostra (page 217).

PLATE XCV A. FIG. 1 *a*, *b*, *c*. (These figures are referred, at page 217, to Plate XXXVI A, fig. 1 *a*, *b*, *c*.)

CAMARIUM.

AMONG the fossils referred by me to the Genus MERISTA, and published in the Report of the Regents of the University in 1856 and 1857, and printed in this volume in the year last mentioned, are several, which, although possessing the general form of *Merista*, present nevertheless some noticeable peculiarities. One of these is the strongly incurved beak of the ventral valve, while the cardinal margin is abruptly bent inwards, leaving an angular or subangular ridge extending from the beak to the margin of the shell, the space between this and the cardinal margin being sometimes flattened about halfway to the base. The front of the shell is often produced in a broad linguiform extension of the ventral valve :

there is sometimes no depression on the middle of the valve, and sometimes a strong angular sinus. Some separated valves of specimens from Maryland show an arching transverse septum below the rostral cavity, rising from the inner surface of the shell and leaving a deep pit beneath.

The casts present an appearance somewhat as if there had been a double rostral cavity, one below the other. Although the internal structure is but partially determined, I can have no hesitation in separating it from the more abundant forms which I have recognized as *Merista;* and I have proposed for these fossils the generic designation of CAMARIUM.

GENUS CAMARIUM (n. g.).

[Gr. καμαρα, *fornix;* in reference to the arching septum.]

Terebratula and *Atrypa*, in part, of authors.
Merista, in part : DAVIDSON, HALL, and other authors.
Camarium : HALL, 1858.

SHELLS ovoid or elliptical, and sometimes depressed subglobose : valves articulating by teeth and sockets; beak of ventral valve perforate. Interior of ventral valve marked by an arching transverse septum about one-third the distance from beak to base. The inner surface of the shell, above and below the septum, marked by muscular imprints : structure of the crura, etc. of the dorsal valve unknown. Ventral valve ventricose, flat or sinuate in the middle, and produced in a sublinguiform extension in front.

SURFACE marked by fine concentric striæ; and partially exfoliated specimens show some obscure radiating striæ.

From the similarity of structure, I have presumed these forms to belong to the same group as *Spirigera* and *Merista;* but the presence of the transverse septum seems incompatible with the existence of the internal spires which characterize those genera.

Under this genus I include *Merista princeps* and *M. meeki* (Pal. N.Y. Vol. iii, pp. 251 & 252, excluding figures 1 – 3, which may be regarded as doubtful). I have not yet been able to determine the internal structure, so far as to make satisfactory comparisons with similar parts of *Camarophoria*.

Camarium typum (n. s.).

PLATE XCV A. FIG. 2 *a* & *b*, 3, 5 & 6.

SHELL short-oval or subelliptical, length but little greater than the width, very ventricose or subglobose. Ventral valve much the larger, extremely arcuate, the curvature from beak to base being somewhat more than half a circle; most gibbous on the umbo and near the front, which is bent abruptly upwards, and produced into a broad rounded extension: beak incurved, thin and pointed; umbonal slopes sharply angular, subparallel to the cardinal margin, with a moderately broad, smooth, and slightly concave space between; foramen large, triangular, reaching nearly to the extremity of the beak. Dorsal valve most gibbous on the umbo, elevated in front into a prominent mesial fold; the sides curved downwards, and produced to meet the receding edges of the opposite valve: beak rather large, incurved beneath the opposite beak, and apparently filling its foramen.

The interior of the ventral valve has a deep large rostral cavity, and a more or less highly arched transverse septum, which, rising from beneath the rostral cavity, extends to near the middle of the valve, and reaches about two-thirds across its transverse diameter. From the bases of the dental plates, rise two diverging thickened elevated ridges, which extend to the sides of the arching septum, and, uniting with it, gradually die out upon its surface.

SURFACE of the shell, when sufficiently well preserved, bears evidence of faint radiating striæ.

Fig. 2 *a*. Dorsal view of *Camarium typum*.
Fig. 2 *b*. Profile view of the same,
Fig. 3. Interior of the ventral valve, showing the transverse arching septum.
Fig. 5. A longitudinal section of fig. 3.
Fig. 6. A cast of the interior of a valve similar to fig. 3.

Geological position and locality. In rocks of the age of the Lower Helderberg group: Cumberland, Maryland.

Camarium elongatum (n. s.).

PLATE XCV A. FIG. 4.

SHELL elongato-ovate, somewhat ventricose. Ventral valve convex, most gibbous on the umbo, having a broad low subangular prominence along the middle to near the front of the valve, which is slightly produced and little elevated : beak produced, slightly incurved; umbonal ridges rounded; foramen, large, triangular. Dorsal valve unknown.

The interior of the ventral valve has a broad and deep rostral cavity; transverse septum much elongated, extending considerably beyond the middle of the valve, and embracing about one-half of the transverse diameter. The ridges which rise from the bases of the dental plates diverge and pass outside of the transverse septum, sometimes leaving a deep and narrow channel between them.

This shell differs from *C. typum* in being more elongate and less ventricose, and in having the beak as well as the front less abruptly curved : the transverse septum is proportionally narrower, and extends farther along the valve; while the ridges of the dental plates do not unite with the septum, but pass along the outside of its base.

Fig. 4. The interior of a ventral valve of this species : the sides of the valve, and a part of the arching septum, have been broken away.

Geological position and locality. The same as the preceding.

PHOLIDOPS.

Among the fossils described in the second volume of the Palæontology of New-York, there is a *Discina*-like or patelloid shell, which I there termed *Orbicula squamiformis**.

The shells heretofore referred to the Genus Orbicula are properly Discina; and all the shells of this genus, which we know, have the dark color and phosphatic composition of the recent species. The shell referred to above, and other similar forms, are light-colored and calcareous in composition, and a farther discovery of similar forms proves them to have no relation with Discina. It is not easy to determine whether these small shells are bivalve brachiopods, or univalve like *Capulus;* since the only specimen seen, with two valves conjoined, admits of some doubt as to the parts being in their natural relation to each other. From the resemblance of the interior of one of these shells, and the flattened triangular space beneath the apex, I had supposed them to have some relation with *Crania;* but in order to avoid any confusion, I have not adopted a name suggestive of any such relation, which may after all be merely apparent; and I would suggest the name *Pholidops*, from the squamiform appearance of several of the species.

Genus Pholidops (n. g.).

Shells small patelliform : apex subcentral, excentric or terminal. Surface marked by concentric lamellæ of growth, which are more expanded on the posterior side. Interior a shallow oval cavity, with bilobed muscular impressions; the margin flattened or slightly deflected, and entire.

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* Palæontology of New-York, Vol. ii, p. 250.

Pholidops squamiformis (Hall).

Plate CIII B. Fig. 6 *a*, *b*.

Orbiculu squamiformis : Report of the Fourth Geological District, 1843, pag. 108, fig. 1.
— — Palæontology of New-York, Vol. ii, pa. 250, pl. 93, f. 4 *a*, *b*.

Shell oval or subquadrate oval, very depressed : apex excentric. Surface marked by strong concentric lamellæ, which are close together on the anterior, but wider and diverging on the posterior part of the shell. Shell thin, translucent. Fine radiating striæ cross the lamellæ in well preserved specimens.

Fig. 6 *a*. Interior of a specimen of the natural size. Fig. 6 *b*. The same enlarged.
For the exterior of the shell, see Plate liii, vol. 2.

Geological position and locality. In the shale of the Niagara group : Lockport, Rochester, and Sweden, New-York.

Pholidops ovatus (n. s.).

Plate CIII B. Fig. 7 *a*, *b*.

Shell ovate : apex excentric. Surface marked by fine concentric lamellæ of growth, which are wider on the posterior part of the shell. Very minute radiating striæ are sometimes visible.

This shell resembles the Niagara species; but the lamellose striæ are finer and more closely arranged, and the shell is often proportionally broader.

Fig. 7 *a*. Exterior of a specimen of the natural size. Fig. 7 *b*. The same enlarged.

Geological position and locality. In the shaly limestone of the Helderberg group: Albany county.

Pholidops terminalis (n. s.).

Plate CIII B. Fig. 8 *a*, *b*, *c*, *d*.

Shell subelliptical, broader behind, and narrowing to the apex ; apex terminal. Surface marked by strong squamiform lamellæ : a flattened subtriangular space beneath the apex; the inner margins of the shell

somewhat flattened. The muscular impression is double, and situated on each side of a mesial ridge, which becomes thickened and expanded towards the apex.

This species differs from the preceding in the terminal apex, and in the stronger concentric lamellæ.

Fig. 8 *a*. The exterior of the shell, of the natural size.

Fig. 8 *b*. Two valves in conjunction. It is not determined that these valves are in their natural relations, and no articulating processes have been observed.

Fig. 8 *c*. The interior of another specimen.

Fig. 8 *d*. The same enlarged.

Geological position and locality. In the Oriskany sandstone : Cumberland, Md.

Conocardium inceptum (n. s.).

SHELL obliquely subovate; posterior extremity subobtuse; beaks subanterior. Anterior end short, rounded; the hiatus rounded in front and narrowed behind, reaching about half the length of the base. Surface of the posterior portion marked by five or more strong ribs on each valve. The anterior parts of the valves are marked by radiating striæ, which are likewise more faintly shown on the ribs of the posterior part of the shell. The whole surface marked by concentric lamellose striæ, which are much stronger on the anterior part of the shell, and, at the crossings of the radiating striæ, marked by little granules or spinules, and the continuation of these into the hiatus gives a denticular character to the margins.

I have seen but a single distorted specimen of the species, and the hinge-line is obscured by adhering stone. It is the only specimen of the genus that I have yet observed in any of the rocks below the Upper Helderberg limestone, and this one was not observed till after the plates of this part of the volume had been completed.

Geological position and locality. In the shaly limestone of the Lower Helderberg group : Albany county.

CATALOGUE OF SPECIES,

AND NUMBER OF INDIVIDUALS OF EACH,

OBTAINED FROM THE SHALY LIMESTONE OF THE LOWER HELDERBERG GROUP, AT A SINGLE LOCALITY IN ALBANY COUNTY*.

The collection of fossils from the Lower Helderberg rocks was begun in Albany county, and elsewhere, in 1843. In many localities the shaly limestone of this group is of such a character that it decomposes on its outcrop; while the fossils, being silicified, remain uninjured, and are found among the fine debris along the slope of the escarpment. I engaged the service of persons living upon the ground, mostly of children who were able to collect from the ploughed fields and elsewhere along this outcrop. The area from which collections were chiefly made does not exceed a quarter of a mile in width by half a mile in length, though a small number of specimens may have been obtained at a greater distance. The specimens collected for a period of about three months were turned over, without counting, to Mr. Seaman of Paris, who was then travelling and making collections in this country, and are not included in the number specified in the following lists.

During the time from 1853 to 1857, the collections were not as constantly continued: fewer persons were engaged, the work being expensive; and having already all the species likely to be obtained, I did not press the collections as before.

During the years 1857 and 1858, large numbers of specimens were obtained from this locality: every new ploughing of the ground turns up a fresh crop of these fossils, and the locality is still very prolific.

Of the little *Orthis varica*, great numbers may still be obtained; and

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* Some years since, I prepared this schedule, as far as the collections had then been made, to communicate to Prof. Edward Forbes, under the title of the results of "Dry Dredging", in acknowledgment of some papers on dredging sent me by that eminent and lamented naturalist. The news of his death prevented the communication from being sent; and I have recently added the results of later collections, and present it in this form, which may have some little interest, both to naturalists who are dredging in the present ocean, as well as those who are collecting the fauna of an ancient sea.

notwithstanding it is so abundant at this locality, it is extremely rare at the distance of a few miles : indeed I have no specimen in my collection from any point five miles distant from the one here indicated.

The *Trematospira costata* is so extremely rare, that but a single specimen was obtained in all this time; while among collections subsequently made by other parties, I have detected two other individuals.

The *Spirifer concinna* is abundant in the Upper Pentamerus limestone (the rock succeeding the Shaly limestone), at Schoharie and Cobleskill; but I have seen only the single specimen from the shaly limestone, during all these years of collecting in the Helderberg. A similar example occurs in the little *Rhynchonella semiplicata*, which is abundant in the Pentamerus limestone, a heavy bedded stratum lying below the Shaly limestone; while but two specimens have been seen in all these collections from the latter rock.

It has not been in my power to make collections in other localities, with the same degree of care and completeness as from this one.

	1843 to 1853.	1853 to 1857.	
Orthis oblata	2384	277	Since these determinations were made, I have separated from them the species *O. discus*; but the proportional number of specimens has not been ascertained.
" discus			
Orthis subcarinata	2783	458	A later critical examination of the specimens referred to the *Orthis subcarinata*, has enabled me to separate from all the collections ten specimens of *O. planoconvexa*.
" planoconvexa			
Orthis perelegans	456	158	
" tubulostriata	14	21	
" deformis	1	1	
" eminens	0	0	This species is extremely rare in the Helderberg mountains.
" varica	40000	3960	The falling off in the product of this species arose from the little encouragement given to collect the specimens, and perhaps from partial exhaustion.
Orthis (small)	500	353	These specimens are, perhaps, the extreme young of *O. oblata* and allied species.
" "	150	229	These specimens are probably the extremely young individuals of *O. subcarinata* and *O. perelegans*, which are not easily distinguishable from each other.
Orthis strophomenoides	12		
Strophomena depressa	50	20	
Trematospira costata	1	0	Two other specimens of this species have since been obtained by other parties, making three now known.
" multistriata	15	0	

	1843 to 1853.	1853 to 1857.	
Spirifer macropleura	75	27	
" perlamellosa	1389	1835	
" cycloptera	56	49	
" concinna.....	1		This species is not uncommon in the Upper Pentamerus limestone.
" ventricosa	637	107	
Cyrtia dalmanii	81	13	
Pentamerus galeatus	353	97	
" verneuili	524	182	
Atrypa reticularis	1380	516	
Eatonia singularis	75	10	
" medialis	135	71	
Merista lævis	57	10	
" arcuata	117	8	
" bella	51	17	
Rhynchonella semiplicata,	1+1?	0	This species is abundant in the Pentamerus limestone, below the Shaly limestone.
" mutabilis	72	10	
" pyramidata ...	429	472	
" vellicata.....	36	6	
" campbellana ..	8	1	
" eminens	2	2	
" acutiplicata..	var. 5 + var. 15	1	
" transversa	11	2	
" sulcoplicata ...	25	0	
" bialveata	42	3	
" inutilis	35	12	
Rhynchospira deweyi ...	9	1	
" globosa.....	150	21	
" formosa	125	38	
Rensselæria mutabilis ...	2		
Leptocœlia concava	912	154	
" imbricata	351	191	
" imbricata, *var.*..	170		
Zaphrentis	1260	297	
Streptelasma	338	38	

I. SUPPLEMENT TO VOL. I.

NOTES UPON THE GENUS GRAPTOLITHUS;

WITH REMARKS UPON SOME OF THE SPECIES, THEIR MODE OF GROWTH, AND MANNER OF REPRODUCTION OR GERMINATION.

THE short time allowed, and the limited means at my disposal, for the investigations and collections for the first volume of the Palæontology of New-York, prevented that careful and continued examination of many of the fossiliferous beds which becomes so desirable in the present state of the science and the requirements of geology*. Notwithstanding this, however, fifteen species of Graptolites were determined, ten of which were at that time new; while of those identified with European species, we may still raise the question as to positive specific identity, and, with the addition of new material, the subject at this time requires a thorough revision. At that time the peculiar branching forms of the genus were first made known, and, so far as I am aware, a greater variety of form and character illustrated than had previously been observed.

Two other species from the Clinton group were described in the second volume of the Palæontology of New-York, one of these being referable to the Genus GLADIOLITES. In the same volume I described the Genus DICTYONEMA, referring it to the Family GRAPTOLITIDÆ.

* The first volume of the Palæontology of New-York was published in less than four years from the time the work was placed in my charge, and this without an assistant of any kind furnished by the State; and the entire collections, except a small number previously in the State collection, were made at my private expense. This state of things, and the comparatively imperfect knowledge of the rocks at that time possessed by every one, may offer some excuse for many omissions and some imperfections.

n a short paper published in the Proceedings of the American As-
iation for the Advancement of Science for 1849, I stated that the
raptolites were not represented in the higher Silurian, Devonian or
arboniferous strata. Subsequently, however, in the same year, I deter-
nined the Genus DICTYONEMA to belong to the Graptolitideæ; and this
opinion was expressed in the second volume of the Palæontology of
New-York in 1850 (though the volume was not published till 1852). The
DICTYONEMA, on farther examination, has proved to be an unequivocal
graptolitic genus, consisting of radiating filaments or branches which are
connected together by transverse bars, and form flabellate or funnelshaped
fronds growing from a radix, and having the inner side of the branches
serrated*. The DICTYONEMA is known in the Niagara group, the Upper
Helderberg limestones, and in the Hamilton group; while the Genus
PLUMALINA, which may be regarded as an allied form, is known in the
Chemung group.

The Graptolitideæ are therefore at this time clearly traced to the base
of the Carboniferous system, and we may probably find allied genera to
the close of the Palæozoic period.

Various opinions had been entertained, not only as to the nature of the
Graptolites, but likewise as to their mode of growth; and it was not until
1854 that the researches in the Geological Survey of Canada brought to
light some remarkable and unique forms, which for the first time gave us
a true idea regarding their perfect form and manner of growth.

Through the kindness of Sir WILLIAM E. LOGAN, these specimens we
placed in the hands of the writer, and some observations upon them we
communicated to him in 1855 : that notice was soon after read bef
the Geological Society of France, and otherwise made public in Eur
The following extract from the Report of Progress of the Geolo
Survey of Canada for 1857 will serve to give a more perfect idea o
discovery, and of the character of the fossils.

* Mr. SALTER was the first to announce publicly the serrate character of these branches, a
cognizing his fossil as identical with DICTYONEMA, proposed the name GRAPTOFORA in 1857.

CANADIAN GRAPTOLITES.

REPORT OF JAMES HALL, ESQ., ADDRESSED TO SIR WILLIAM E. LOGAN, F.R.S., DIRECTOR OF THE GEOLOGICAL SURVEY OF CANADA.

ALBANY, MARCH 1, 1858.

SIR — In reply to your inquiry regarding the Graptolites and other allied genera, confided to me for description on behalf of the Geological Survey of Canada, partly in 1854 and partly at a subsequent time, I have the honor to inform you that six plates of the Graptolites have been engraved, and are now only waiting to be lettered, and that drawings for ten plates more are in the engraver's hands.

The description of twenty-four species accompanies the present communication, and the plates will follow as fast as they are completed.

In April 1855, I communicated to you a note upon these remarkable graptolites, discovered in the progress of the Geological Survey of Canada during the previous year. This discovery gave for the first time a knowledge of the true forms and mode of growth of these fossils, of which fragments and detached branches have for so many years been described as complete forms. Neither up to that time, nor, so far as I am aware, to the present, has any evidence of the existence of perfect forms such as these been given to the public.

Two of the species were described in the note transmitted to you in 1855, and I have preceded the description of the remainder by a repetition of that note.

I have the honor to be, Sir, your most obedient servant,

JAMES HALL.

NOTE *upon the* Genus GRAPTOLITHUS, *and Descriptions of some remarkable new forms from the shales of the Hudson-river group, discovered in the investigations of the Geological Survey of Canada, under the direction of* Sir W. E. LOGAN. *By* JAMES HALL. [Communicated in April, 1855.]

THE discovery of some remarkable forms of the Genus GRAPTOLITHUS, during the progress of the Canada Geological Survey, has given an opportunity of extending our knowledge of these interesting fossil remains. Hitherto our observations on the Graptolites have been directed to simple linear stipes, or to ramose forms, which, except in branching, or rarely in having foliate forms, differ little from the linear stipes. In a few species, as *G. tenuis* (HALL) and one or two other American species, there is an indication of more complicated structure; but up to the present time, this has remained of doubtful significance. The question whether these animals, in their living state, were free or attached, is one which has been discussed without result; and it would seem to be only in very recent times that naturalists have abandoned altogether the opinion that these bodies belong to the *Cephalopoda*.

In the year 1847, I published a short paper on the Graptolites from the rocks of the Hudson-river group in New-York : to the number there given, two species have since been added from the shales of the Clinton group. Other species, yet unpublished, have been obtained from the Hudson-river group; and since the period of my publication in 1847, large accessions have been made to our knowledge of this family of fossils, and to the number of species then known. The most important publications upon this subject are *Les Graptolites de Boheme*, par J. BARRANDE, 1850; *Synopsis of the Classification of British Rocks, and Descriptions of Palæozoic Fossils*, by Rev. A. SEDGWICK and FREDERICK M'COY, 1851; *Grauwacken Formation in Sachsen, etc.*, von H. B. GEINITZ, 1852.

The radix-like appendages, known in some of our American as well as in some European species, have been regarded as evidence that the animal in its living state was fixed; while M. J. BARRANDE, admitting the force of these facts, asserts his belief that other species were free. It does not,

however, appear probable that in a family of fossils so closely allied as are all the proper *Graptolitideæ*, any such great diversity in mode of growth would exist.

It will appear evident from what follows, that heretofore we have been compelled to content ourselves, for the most part, with describing fragments of a fossil body, without knowing the original form or condition of the animal when living. Under such circumstances, it is not surprising that various opinions have been entertained, depending in a great measure upon the state of preservation of the fossils examined. The diminution in the dimensions, or perhaps we should rather say in the development, of the cellules or serrations of the axis towards the base, has given rise to the opinion advanced by BARRANDE, that the extension of the axis by growth was in that direction, and that these smaller cells were really in a state of increase and development. In opposition to this argument, we could before have advanced the evidence furnished by *G. bicornis*, *G. ramosus*, *G. sextans*, *G. furcatus*, *G. tenuis*, and others, which show that the stipes could not have increased in that direction. It is true that none of the species figured by BARRANDE indicate insuperable objections to this view; though in the figures of *G. serra* (BRONGNIART), as given by GEINITZ, the improbability of such a mode of growth is clearly shown.

It is not a little remarkable that with such additions to the number of species as have been made by BARRANDE, M'COY and GEINITZ, so few ramose forms have been discovered; and none, so far as the writer is aware, approaching in the perfection of this character to the American species.

Maintaining as we do the above view of the subject, which is borne out by well-preserved specimens of several species, we cannot admit the proposed separation of the Graptolites into the genera *Monograpsus*, *Diplograpsus* and *Cladograpsus*, for the reason that one and the same species, as shown in single individuals, may be *monoprionidean* or *diprionidean*, or both; and we shall see still farther objections to this division, as we progress, in the utter impossibility of distinguishing these characteristics under certain circumstances. We do not yet perceive sufficient reason to separate the branching forms from those supposed to be not branched;

for it is not always possible to decide which have or have not been ramose, among the fragments found. Moreover there are such various modes of branching, that such forms as *G. ramosus* present but little analogy with such as *G. gracilis*.

M. GEINITZ introduces among the *Graptolitideæ* the Genus NEREOGRAPSUS, to include *Nereites*, *Myrianites*, *Nemertites* and *Nemapodia*. Admitting the first three of these to be organic remains, which the writer has elsewhere expressed his reasons for doubting, they are not related in structure, substance, or mode of occurrence, to the Graptolites, at least so far as regards American species; and the *Nemapodia* is not a fossil body, nor the imprint of one, but simply the *recent track of a slug* over the surface of the slates. The Genus RASTRITES of BARRANDE has not yet been recognized among American *Graptolitideæ*. These forms are by GEINITZ united to his Genus CLADOGRAPSUS, the propriety of which we are unable to decide.

The Genus GLADIOLITES (RETIOLITES of BARRANDE, 1850; GRAPTOPHYLLIA of HALL, 1849) occurs among American forms of the *Graptolitideæ* in a single species in the Clinton group of New-York. A form analogous, with the reticulated margins and straight midrib, has been obtained from the shales of the Hudson-river group in Canada; suggesting an inquiry as to whether the separation of this genus, on account of the reticulated structure alone, can be sustained. In the mean time we may add that the Canada collection sustains the opinion already expressed, that the DICTYONEMA will form a genus of the Family *Graptolitideæ*. The same collection has brought to light other specimens so unlike anything heretofore described, that another very distinct genus will thereby be added to this family. The Canadian specimens show that the Graptolites are far from always being simple or merely branching flattened stems.

The following diagnosis will express more accurately the character of the Genus GRAPTOLITHUS, as ascertained from an examination of perfec specimens in this collection.

GENUS GRAPTOLITHUS (LINNÆUS).

CORALLUM or bryozoum fixed (free?), simple or compound; the parts bilaterally arranged, consisting of simple stipes or of few or many simple or variously bifurcating branches, radiating more or less regularly from a centre, and, in the compound forms, united towards their base in a continuous thin corneous membrane or disk formed by an expansion of the substance of the branches, and which in the living state may have been in some degree gelatinous. Branches with a single or double series of cellules or serratures, communicating with a common longitudinal canal, affixed by a slender radix or pedicle from the centre of the exterior side.

The fragments, either simple or variously branched, hitherto described as species of GRAPTOLITHUS, are for the most part to be regarded as detached portions from the entire frond.

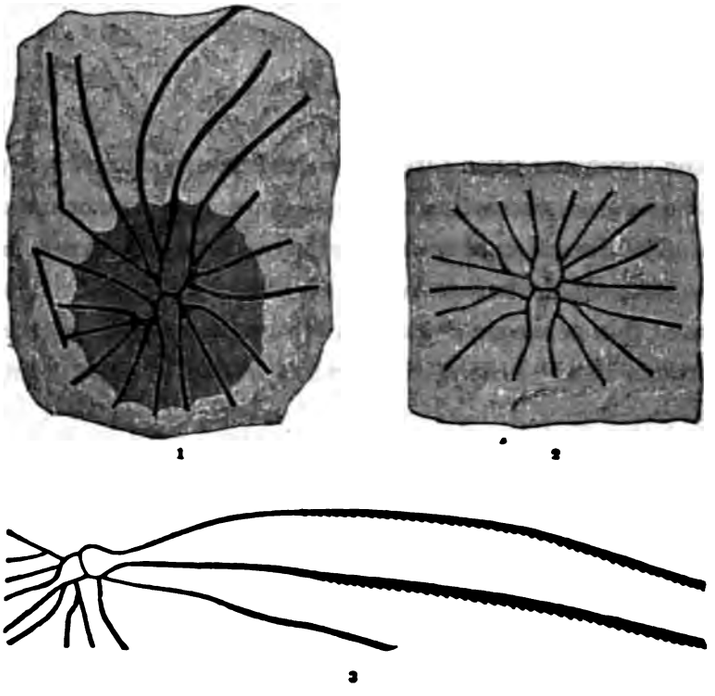
In the living state, we may suppose those with the corneous disks and numerously branched fronds to have been concavo-convex (the upper being the concave side), or to have had the power to assume this form at will. In many specimens there is no evidence of a radix or point of attachment, and they have very much the appearance of bodies which may have floated free in the ocean.

The accompanying figure 1 is the central portion of one of these graptolites, showing the bilateral arrangement of these branches and the bifurcation of the same. The disc enclosing the bases of the branches is well preserved, while most of the rays are broken off a little beyond its margin. The side presented is the lower or exterior of the specimen, and the serratures are not visible.

Fig. 2 is a specimen of the same species, from which the substance of the disc is removed, showing the serrated margin which is compressed in that direction.

Fig. 3 shows the central portion or radix, with the bases of the branches; while two of these are shown in their extension, laterally compressed and showing the serratures. The entire length of some of these branches is about seven inches.

Graptolithus logani.



1 2 3

Graptolithus logani.

Frond composed of numerous branches nearly equally disposed on two sides of a central connecting stipe, and each again subdividing nearly equally; after which they bifurcate, always near the base, with greater or less regularity: connecting membrane thin, composed of the same substance and continuous with the branches, extending from the centre to some distance beyond the bifurcations. The branches, after the third bifurcation, become marked on the inner side by a row of cellules, and along the centre by an abruptly impressed line which follows the divarication of the branches: cellules minute, not prominent towards the base of the branches, being compressed vertically, and appearing like a double series with a central depressed line, becoming developed as they recede from the base. The branches beyond the disc are turned on one

side and laterally flattened, and present a single series of cellules or serrations, which are moderately deep, with the serratures acute at their extremities; from twenty-four to twenty-eight in an inch. The substance of the branches, upon the exterior surface near the centre, is marked by a depressed longitudinal line, which follows the ramifications, and gradually dies out as the branches become finally simple, when the surface on the same side is smooth or somewhat obliquely striated. The disc is smooth exteriorly; and from the centre is a small radicle, from which the two sets of branches diverge.

This species, though in a general manner bilateral and presenting four principal branches, is, nevertheless, from the irregular division of these, usually unequal upon the two sides; and we find on examination of those figured that they are as ten and ten, nine and eleven, eight and nine, ten and eleven, seven and ten, twelve and twelve, eight and eight, eight and ten, while the half which is figured (plate ii) has eleven rays.

Locality and formation. These specimens were obtained at Point Levy, opposite to Quebec, in a band of bituminous shale separating beds of gray limestone. These strata belong to the Lower Silurian series, and are of that part of the Hudson-river group which is sometimes designated as Eaton's sparry limestone, being near the summit of the group : they form also the rocks of Quebec.

Graptolithus abnormis.

This species, of which only imperfect specimens have been seen, presents four principal branches diverging from the centre, two from each extremity of the vinculum, and each one of these bifurcating and branching unequally and at unequal distances from the centre.

The forms above described do not by any means exhaust the varieties presented in this collection. With a single exception, however, all the specimens which offer any new light in regard to the habit of the Graptolites indicate that the mode of growth was in the manner described, in branches radiating from a centre, or in tufts joining in a central connecting substance.

The specimens from the Canadian locality afford further evidence in confirmation of what we have elsewhere observed, that, with few exceptions, the species have a limited geographical range. This locality has already, after very cursory examination, afforded eight new species of Graptolites, with one or two species which appear to be identical with those previously found in the State of New-York. A compari-

son of specimens from more southern localities, with those of New-York, shows a large proportion of new species; and it now appears probable that the number of American species of GRAPTOLITHUS previously known (about twenty), will soon be increased by an equal number of new ones.

Locality and formation. Point Levy, Canada : Hudson-river group.

In addition to the species above noticed, the following are published in the same Report for 1857 :

GRAPTOLITHUS FLEXILIS,	GRAPTOLITHUS INDENTUS,
G. RIGIDUS,	G. NITIDUS,
G. OCTOBRACHIATUS,	G. BIFIDUS,
G. OCTONARIUS,	G. PATULUS,
G. QUADRIBRACHIATUS,	G. EXTENSUS,
G. CRUCIFER,	G. DENTICULATUS,
G. BRYONOIDES,	G. PRISTINIFORMIS,
G. HEADI,	G. ENSIFORMIS, and
G. ALATUS,	G. TENTACULATUS.
G. FRUTICOSUS,	

Besides these species of GRAPTOLITHUS, there are some other forms in the Canadian collection, separated by the writer under the name *Phyllograptus*, as follows :

GENUS PHYLLOGRAPTUS.

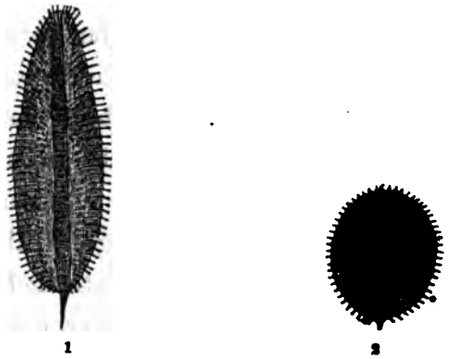
FROND consisting of simple foliate expansions, celluliferous or serrated upon the two opposite sides : margins with a mucronate extension from each cellule; or of similar foliate forms united rectangularly by their longitudinal axes, and furnished on their outer margins with similar cellules or serratures, the whole supported on a slender radicle.

These bodies, which usually appear upon the stone in the form of simple leaf-like expansions, may possibly have been attached in groups to some other support; but the form of some of them, and the character of the projecting radicle at the base, indicate that we have the entire frond. These forms furnish perhaps the best illustration of all the *Graptolitideæ*, of the lesser development of the cells at the base, and their gradual expansion above until they reach the middle or upper part of the frond. Many of them diminish from the centre upwards; and rarely the cells are more developed above the centre, reversing the usual form, and leaving the narrower part at the base.

The species of this genus approach in general form to *G. ovatus* of BARRANDE and *G. folium* of HISINGER. They present, however, some differences of character; varying from broad-oval with the extremities nearly equal, to elongate-oval or ovate, the apex usually the narrower, but in a few instances the base is narrower than the apex. These forms are sometimes extremely numerous in the shales, and present on a cursory examination a general similarity to the leaves of a large species of *Neuropteris* in the shales of the Coal measures.

Instead of the narrow filiform midrib represented in the figures and descriptions of the authors mentioned, these specimens present a broad linear midrib continued from the apex to the base, and extended beyond the base in a slender filiform radicle, usually of no great extent, but in some instances nearly half an inch in length. The midrib is rarely smooth, varying in width, with its margins not often strictly defined. In examining a great number of individuals of one species, I have discovered that this midrib is serrated; and though for the most part the serratures are obscure, they nevertheless present all the characteristics which they exhibit in graptolites of other forms, in which the branches have been compressed vertically to the direction of the serratures.

1 & 2. **Phyllograptus typus** in two extreme forms.



1 2

In this view, the lateral leaflike portions appear to be appendages to the central serrated portion; but these are nevertheless denticulate on their margins, and the intermediate spaces are well defined, as if admitting of no communication by serratures or cellular openings with the centre.

In another species the central axis or midrib is strong and broad, often prominent and distinctly serrate; the edges of the interspaces being all broken off, as if the extremities had been left in the slate cleaved from the surface : at the same time, the lateral portions are so well preserved as to show distinct cellules upon each side. We have therefore three ranges of cells visible, the central axis projecting at right angles to the two lateral parts. This remarkable feature leads to the inference

that this graptolite was composed of four semielliptical parts joined at their straight sides, and projecting rectangularly to each other; presenting on each of the four margins a series of serratures, which, penetrating towards the centre, were all united in a common canal, and all sustained upon a simple radicle.

Under this genus have been described the following species from the Canadian collection :

PHYLLOGRAPTUS TYPUS, P. ILICIFOLIUS, P. ANGUSTIFOLIUS, and P. SIMILIS.

While these discoveries have been made in Canada, giving us for the first time a correct knowledge of the mode of growth and the varying forms of these bodies, I have not neglected opportunities of increasing our knowledge of these fossils from localities within my reach. The locality of graptolites near Albany has heretofore furnished several species, which, now that we know better their original forms, offer additional information, and become of greater interest both in their zoological and geographical relations.

At this locality, some specimens have been obtained which show apparently the mode of reproduction in this family of animals, which is more similar to the hydroid polyps than to the Bryozoa*.

The specimens in which this feature has been observed, first show a slight swelling or vesicle proceeding from the axils of the serratures : this vesicle, which in the beginning is barely perceptible beyond the outlines of the margin, swells and becomes elongated, the extremity finally much inflated, and the base of the footstalk extended and attenuated. As this process of development goes on, the sac or inflated portion curves downwards, and finally becomes ruptured or dehiscent on the lower side near the extremity. At this period, and sometimes previously, the sac, which appears to be an extremely thin membrane and almost without substance, shows one or two elongated fibres, like the central midrib or the marginal longitudinal fibre of the graptolites. At a more advanced stage the substance of the sac gradually disappears, apparently by decomposition, leaving the slender fibre still attached for some time to the axil of the serrature.

* This notice was read at the meeting of the American Association for the Advancement of Science at Baltimore in 1858, accompanied also by references to the Canadian graptolites.

These buds or vesicles do not appear at every serrature, but only on every third or fourth, and are apparently opposite each other on the two sides of the rachis, but in reality alternating as do the serratures. Associated with these specimens, and apparently resulting from these vesicles, are numerous young graptolites. But although these young or embryonic forms of graptolites occur in such great numbers, it cannot yet be said that any specimens have been seen within the sac, or attached to the parent stipe*.

The following figures will render more clear the preceding observations, and illustrate in some degree the forms described.

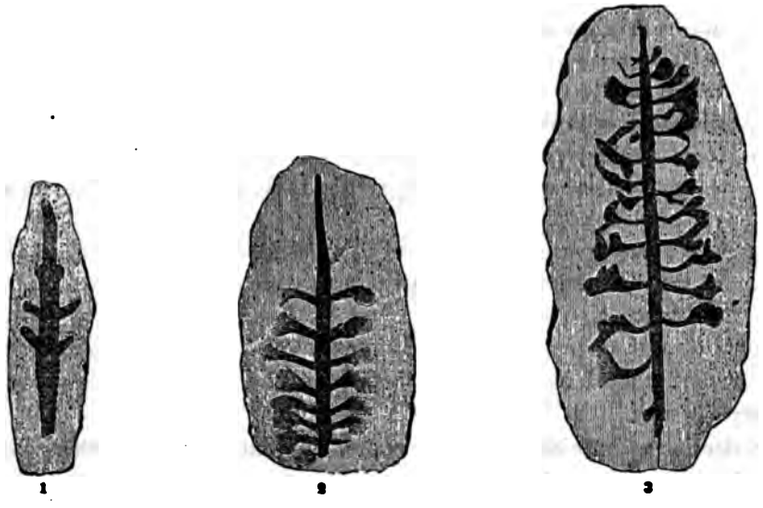


Fig. 1. A fragment of the stipe, showing the earlier development of these buds or vesicles.

Fig. 2. A fragment where these buds are farther developed, and the upper ones less expanded than those below.

Fig. 3. A longer stipe, preserving numerous expanded vesicles in a farther developed condition; the most of them being broken, and some of them partially decomposed or absorbed, while they preserve very distinctly the delicate hair-like fibre before mentioned.

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* The first discovery of a specimen of this character is due to Mr. WHITFIELD, some three years since; and subsequently I have been indebted to Mr. J. B. ELLIS, and to Mr. G. W. TAYLOR, for other specimens of the same, as well as for other forms; while I owe to Mr. HENRY CANFIELD the possession of the very fine specimen of *G. gracilis* figured on page 512. The discovery of the young graptolites has been of later date, and they have recently been observed in large numbers.

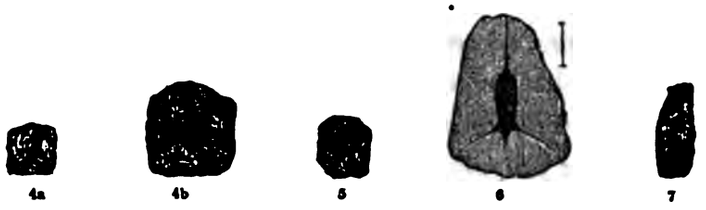


Fig. 4 *a*, *b*. A germ or young graptolite, showing the rootlets below and a short axial fibre extending above. This is a broad form, apparently of the doubly serrated kind, or *diplograpsus*, and appears to be developed to the first serratures. The figures are respectively of the natural size and enlarged.

Fig. 5. A minute specimen of a less symmetrical and apparently less fully developed form.

Fig. 6. Another individual which is farther developed than either of the preceding : the line marks the natural size.

There are several other varieties of form, which, inferring from the central midrib, are of those serrated on the two sides of the stipe, as are all those yet discovered with the vesicles attached.

Fig. 7 is apparently the young of one of the singly serrated forms, from the radical fibre extending along one side and beyond the body, while minute fibres (or rootlets?) extend downwards.

All these young forms preserve the axial fibre extended beyond the substance of the stipe, and there are usually two or three slender fibres extended below in the direction of the radix.

The condition of these bodies, and their association with those bearing the sacs, are so constant, that I have inferred their connection, and that these are in fact the embryonic sacs.

The collection of specimens is quite numerous; but I am still making additions, with the hope that, at no distant period, we may know something satisfactory relative to this newly observed and peculiar development.

The following new species of Graptolites appear to be worthy of notice in this place.

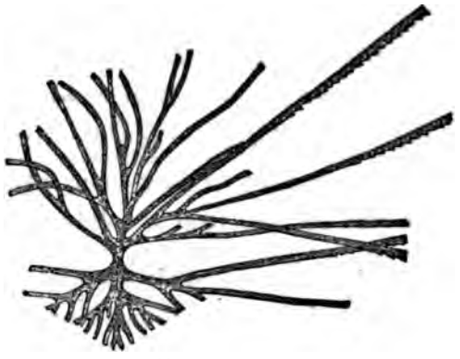
Graptolithus multifasciatus.

Body consisting of numerous bifurcating branches, which are arranged bilaterally on either side of a short strong central bar. The branches bifurcate irregularly, and the subdivisions on one side amount to twenty-one, and on the other to twenty-two, while the specimen is far

from being entire. The branches are serrated on one side : serratures somewhat closely arranged.

The specimen shows the lower or non-serrated surface, and several of the longer branches are turned sufficiently on one side to show the serrations in a tolerable degree of perfection.

Fig. 8. The specimen, natural size.



Graptolithus multifasciatus.

Graptolithus divergens (n. s.).

Body slender, consisting of a straight central stipe or rachis, on each side of the longitudinal centre of which are given off diverging branches in pairs, and nearly opposite each other at the bases : these branches are of unequal length, the longest being frequently as long as the main stipe on either side of its centre. Branches slenderly serrate on one side.

Fig. 9.

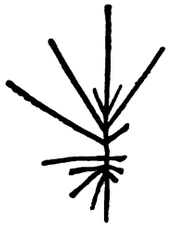


Fig. 9 is an individual of this species, one branch of which appears to bifurcate near its origin.

These species are from the shales of the upper part of the Hudson-river group.

Graptolithus gracilis.

This species was first described in the Palæontology of New-York, Vol. i, p. 274. Its usual form is that of a slender sinuous stipe or rachis, from one side of which are diverging branches which are serrated on one margin only. I have lately farther illustrated this species in the Regents' Report upon the State Collections of Natural History. A subsequent examination of the specimens from the Normans-kill, near Albany, has shown some modifications of its form and mode of occurrence, not before observed, which make it necessary to offer some farther illustrations in this place. The species may be described as follows :

FROND bipartite (or quadripartite?), consisting of two principal stipes : stipes diverging from a point of attachment, and ascending more or less vertically; slightly curved in the young state, and more curved in older forms. Branches originating on the outer or lower side of the rachis; the first ones diverging almost rectangularly, while the later ones are more ascending, as large at their origin as the rachis, and becoming wider in their extension. Young branches thickened and succulent with the serratures obscure, becoming flattened and distinctly serrate in the older forms. In the full-grown specimens, the extremity of the stipe beyond the origin of the last branches is serrate.

The specimens of this species, in their mature condition, all present the peculiarity of having a slender sinuous rachis, approaching in form the letter S, from which the branchlets diverge always on the convex side of the curve, so that ordinarily one half the branchlets proceed in one direction and the other half in the opposite direction. In the young specimens, there is a distinct appearance of a slender process or radicle from which the stipes diverge; and a more critical examination of some of the specimens having the S form, since this fact has been ascertained, discloses the remains of a minute transverse filament; and others show a fracture or separation along the rachis between the two sets of branches, corresponding, as I had before suggested, with the centre or point of origin of the animal body.

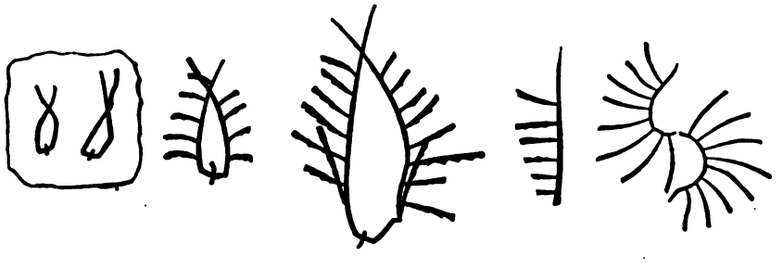
It is barely possible that this apparent central radicle may be the remains of two other stipes, corresponding to the two usually preserved; but we have not thus far

been able to discover any extension of these parts, or evidence of a third or fourth main branch or stipe. Although it is not possible at the present time to determine fully the mode of growth, and the original form of this species when entire, we are nevertheless able to offer some additional information which may be of interest.

In the minute forms which appear to be the young of this species, no lateral branches are developed, while the centre or base is marked by a transverse bar which extends almost equally on either side of the stipe or rachis. The accompanying figures 1 – 4 are illustrations of this form, which are enlarged to twice the natural size, fig. 1 presenting the animal in its earliest observed stage of development.

The second step in the progress of development, which has been observed, is shown in fig. 2, which is from a very beautiful specimen in the collection of Mr. R. P. WHITFIELD : in this one, the general form is similar to that of fig. 1, but it is somewhat larger, and there are five lateral branches on each side. Another individual, somewhat farther advanced, presents eight or nine branchlets on either side, as shown in fig. 3.

FIG. 1. FIG. 2. FIG. 3. FIG. 4. FIG. 5.



At the same time it is not easy to see at once how this form should assume the S-form so common in the specimens observed, and consequently it is difficult to illustrate every stage of the process. We do observe, however, that the main stipes become more curved as they progress; and it is only necessary to spread out, on a flat surface, these two stipes in opposite directions and rectangularly to the direction of the small branches, and we should have a form approaching that in which these fossils usually occur.

The small specimen which I had referred to RASTRITES in my communication to the Regents' Report, is simply one half of one of those young individuals of *G. gracilis*, where the young branches are thickened and not distinctly serrate (fig. 4)*.

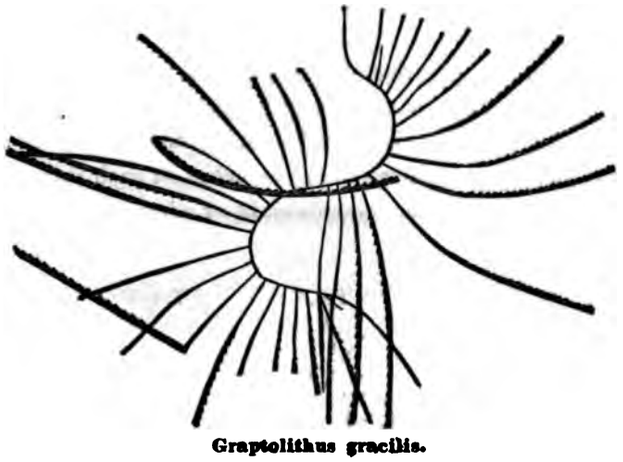
In the original specimen of *G. gracilis* there is a slight interruption in the continuity of the main stipe, as is observed in many individuals of that form ; and

* The specimen figured in EMMONS's American Geology, Plate 1, fig. 6, and described as the type of a new Genus NEMAGRAPTUS, is evidently a fragment of *G. gracilis*.

there is likewise a small process which may be the radicle, as shown in the accompanying fig. 5, of a small specimen preserving the usual form of this species: this figure is of the natural size.

The accompanying fig. 6, of a very beautiful specimen of the *G. gracilis*, is from the same locality as all the others known to me, but shows a greater development of the branches and a more distinct serration than any others in the collection*.

Fig. 6.



Graptolithus gracilis.

This one and the preceding species are remarkably slender, and, although serrated on one side only, present some marked peculiarities when compared with the singly serrated forms with central discs and a bilateral arrangement of the branches, as in *G. logani*, *G. flexilis* and *G. multifasciatus*.

The specimens of this species, which have thus far come under observation, have still some points relative to the mode of growth undecided. It may have grown, in the young state, as shown in figures 1, 2, 3. If, however, the little transverse bar at the base indicates the original existence of two similar stipes or main branches in addition to those already known, the mode of growth may still have been similar, but having four instead of two main branches or stipes. If spread out, as the specimens usually are upon the surface, it may assume the form of the accompanying diagram fig. 7.

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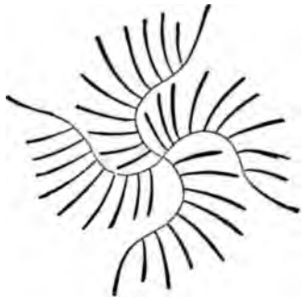
* Although the main stipe was represented as continuous, it is nevertheless partially covered in the centre, or at the radicle-point by the overlapping of one of the bent branches and a little adhering stone.

FIG. 7.



It is still possible that it may have assumed another form in its original mode of growth, and that these small bifurcate fronds are but the separated offshoots from a rhizoma which extended along the muddy bottom of the sea, giving off at intervals the ascending stipes in pairs, which in their progress became branched as before shown ; and in this case, the little transverse bar in the bending of the frond is a part of the broken rhizoma.

Geological position and locality. In the shales of the Hudson-river group : Near Albany.

Graptolithus divaricatus (n. s.).

STIPE bifurcate from the radicle : branches slender, widely diverging, divergence from 90 to 120 degrees, very slightly increasing in width from the base, serrated on the lower side ; serratures nearly straight on the outer margin, with the apices of the denticles somewhat rounded ; the indentation rounded at the bottom, extending across one-half the width of the stipe ; margins of the indentations thickened : the margin opposite the serratures is not thickened.

SURFACE marked by a row of small nodes placed obliquely to the direction of the axis, and situated just below and a little on one side of the bottom of the serrature. Serratures 22 – 26 in the space of an inch.

This species somewhat resembles in its general form, when the stipes are widely divergent, the *G. serratulus;* but the serratures are on the lower instead of the upper margin of the stipe, and are quite different in form and proportions. The small nodes or tubercles are, also, so far as known, a distinguishing feature. In this species these nodes are distinctly oval in form, and have a depression or slit in the summit; and

from their appearance and relation to the serratures, I infer that they are of more importance in the organization than simply as ornament.

Graptolithus divaricatus.

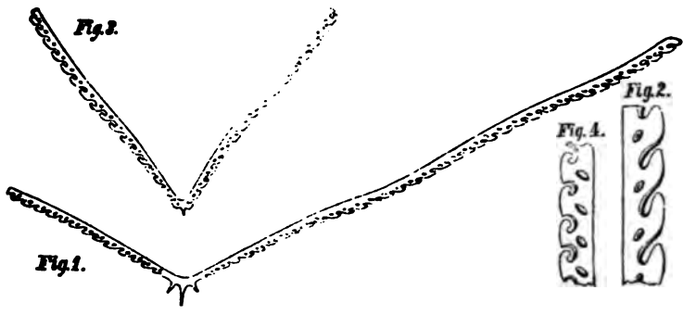


Fig. 1. A large individual, where the divergence of the parts is much greater than in figure 3. The figures are twice the natural size of the specimens.

Fig. 2. A part of the stipe still farther enlarged, showing the serratures and the small nodes.

Fig. 3. An individual, where the divergence is less than 90 degrees.

Fig. 4. A part of fig. 3 much enlarged, to show the form of the serrature.

Geological position and locality. In the shales of the Hudson-river group : Normanskill near Albany.

Graptolithus marcidus (n. s.).

FROND simple, biserrate : stipe short, rigid; midrib strong; serrations deep, the denticles small, triangular, subobtuse, arranged in the proportion of twenty-eight to thirty-two in the space of an inch, often somewhat alternating on opposite sides of the stipe, which is terminated below by two or three longer denticles which are of the same substance as the body of the stipe. The apex is marked by an extended fibre or continuation of the axis.

The specimens of this species which I have seen are usually not more than from one-half to seven-eighths of an inch in length. The axis is narrow; the points of the serrations separated, leaving a defined triangular indentation; and the aspect is that of a contracted or shrunken stipe, and by this character alone is very readily distinguished. It has been observed in considerable numbers, so that we can have no doubt as to the constancy of its characters.

Graptolithus marcidus.

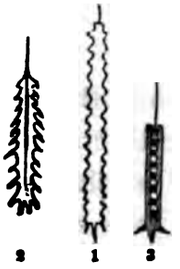


Fig. 1. A specimen more contracted than usual, with the serratures obtuse.

Fig. 2. An individual presenting a more expanded form, with distinct denticles at the lower extremity and a minute radicle below.

Fig. 3. A young form where the serratures are not developed, or are flattened in the line of their direction, and in which the minute fibres or radicles at the base are well preserved. The specific relations of these forms have not been fully determined; and I am, at present, unable to refer them to any other than this one.

Geological position and locality. In the shales of the Hudson-river group : Near Albany.

Graptolithus angustifolius (n. s.).

STIPES simple, linear, slender, biserrate : serratures well defined, the denticles short ovate-acute, the extremities sometimes subobtuse; base marked by minute setiform radicles; midrib projecting beyond the serrated portion in a capilliform extension. Serratures arranged in the proportion of about twenty-eight to thirty in the space of an inch.

This species has a narrow stipe with very distinct denticles, which are usually closely arranged or apparently overlapping each other at the base, while sometimes they are separated more distinctly and the indentation deeper. The form and proportions of these denticles are different from those of any species of Graptolite in the collections from these shales, and often more resembling the minute denticulations on the fronds of fossil ferns than those of the graptolites. The denticles are often subalternate on the opposite sides of the stipe, and frequently variable in the same individual.

The accompanying figures illustrate the usual characters of this species.

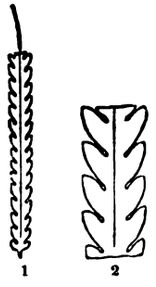


Fig. 1. A single stipe, twice the natural size.

Fig. 2. A portion still farther enlarged.

This species is associated in the same laminæ of slate with *G. marcidus*, *G. whitfieldi*, *G. spinulosus*, and *Retiograptus geinitzianus*.

Geological position and locality. In the shales of the Hudson-river group : Near Albany.

Graptolithus whitfieldi (n. s.).

STIPE simple, flat, gradually expanding from the base to near the middle of its length, the upper part gradually narrowing in the direction of the apex, rarely continuing of the same width above the middle : serratures shallow, angular; the upper margin of the denticles short and nearly rectangular to the axis, the lower side twice as long as the upper, the tips furnished with mucronate or short setiform extensions which project in a line with the upper margin of the denticle. Serratures twenty-two to twenty-eight in the space of an inch.

LENGTH from one inch to an inch and a half.

This species has the general form and proportions of the *G. pristis* (HALL, Pal. New-York, Vol. i, pa. 265, pl. 72, f. 1); but that species does not contract its width towards the upper extremity, the denticles are concave above, and the points directed upwards. The form of the serratures and denticles is quite different in the two species, and the setiform processes are never observed on that species as in this one, where it is a constant feature.

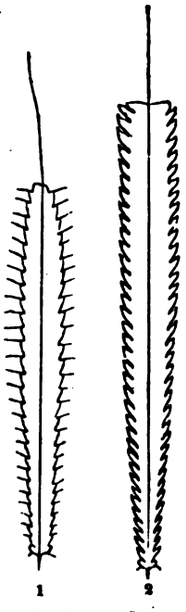


Fig. 1. G. whitfieldi. Fig. 2. G. pristis.

The present form is not unlike the one described as *G. mucronatus* (HALL, Pal. New-York, Vol. i, pa. 268, pl. 73, f. 1); but that species has differently formed serratures and denticles, and the entire stipe is more lax. The upper margins of the denticles are traceable nearly to the midrib in well-marked specimens of that species, and the mucronate tips appear to be formed by the gradual narrowing and extension of the substance of the denticle; while in this one, it is an abrupt extension from the apex of the denticle.

For the purpose of comparison with the *G. pristis*, I have presented figures of the two species, which are enlarged to twice the natural size.

These specimens are from the same locality, and the differences are constant.

Geological position and locality. In the shales of the Hudson-river group : Nes Albany.

Graptolithus spinulosus (n. s.).

Stipe simple, flat; sides subparallel, gradually expanding from the base, which is furnished with several minute setiform radicles : serratures not distinct, the margin sinuous, the prominent parts extended into slender ascending spinuliform processes. These spinules are about one-sixteenth of an inch distant from each other.

This species presents no distinct serratures on the margin, which is simply undulating with the extension of the processes described, which probably mark the place of the serrature. It has been seen only in small individuals or fragments; but its great comparative width, the rigid distant spinules and absence of defined serratures are distinguishing characters.

The accompanying figure is of a fragment of this species, twice the natural size.

Geological position and locality. In the shales of the Hudson-river group : Near Albany.

The Genus Gladiolites or Retiolites of Barrande was proposed for certain graptolitic forms having the general features of the biserrate Graptolites, as *G. pristis*, *G. mucronatus*, and others; but the structure of the entire substance of the stipe differs in being apparently minutely celluliferous or reticulate.

The following is the description given by the author :

Genus Gladiolites = Retiolites (Barrande).

"Polypier small, flat, triangular, elongate, formed of two series of symmetrical cellules arranged along the axis. These cellules extend from a single internal canal, which occupies the central part of the polypier: their orifices are disposed upon the sides of the triangle; they make an angle with the axis, and leave no spaces between them."

"The only known species has its surface covered with a film, which appears to envelope it."

I have recognized in the Clinton group of New-York a species corresponding to this generic description, the *R. venosus* (Pal. New-York, Vol. ii, pa. 40, pl. A 17, f. 2), which is there described as a GRAPTOLITHUS. In the Report on the Geological Survey of Canada for 1857, I have described two other species. An examination of some specimens of another similar form from the Hudson-river shales near Albany (New-York) has convinced me that one of these is sufficiently distinct to form the type of a new genus, for which I have proposed the name RETEOGRAPTUS, from its reticulated structure, and from the absence of serratures or cellules reaching to the axis.

Reteograptus geinitzianus (n. s.).

STIPES small, sublinear; sides essentially parallel. Enveloping crust of the stipe finely veined, somewhat thickened : the skeleton reticulate with three or more rows or series of subquadrangular reticulations, without midrib or central axis : no defined cellules or serratures; margins with projecting mucronate or recurved spinules.

The specimens are nearly all deprived of their outer crust, leaving the skeleton alone.

The accompanying figure is from a specimen, twice enlarged.

Geological position and locality. In the shales of the Hudson-river group : Near Albany.

I am by no means certain that this fossil, in its perfect condition, or in all its stages of growth, consists of three rows of cells. The structure and mode of growth in these forms indicates that the cells increase by lateral extension; and a single fragment in the collection gives some evidence of four rows of reticulations, as in other forms of the genus. It is not improbable, also, that in entire specimens we may find evidence of a central axis; since the implied mode of growth, in its similarity to that of the graptolites, indicates this structure.

GENUS THAMNOGRAPTUS (n. g.).

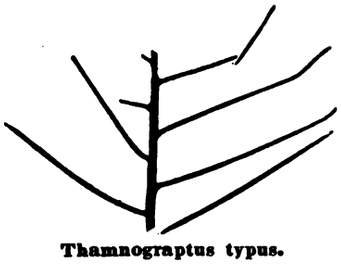
BODIES consisting of straight or flexuous stipes (simple or conjoined at base?), with alternating and widely diverging branches : branches long, simple or ramose, in the same manner as the stipe. Substance fibrous or striate; the main stipe and branches marked by a longitudinal central depressed line, indicating the axis. Cellules or serratures unknown.

These bodies are associated with the Graptolites; and from a general similarity in their substance, I suppose them to belong to the same family of fossils. In all the specimens the surface visible is smooth or striated without indentations, and marked by cross fractures or cleavage planes. The fragments of what appear to be carbonized plants, in the shales of the Hudson-river group, probably all belong to this genus, or to the DENDROGRAPTUS.

Thamnograptus typus (n. s.).

STIPE strong, flattened : branches alternating, about half as wide as the main stipe and expanding at their junction with it, simple, marked along the centre by a depressed line or axis. Surface marked by fine longitudinal striæ, with obliquely transverse fractures or lines of cleavage.

Fig. 1.



Thamnograptus typus.

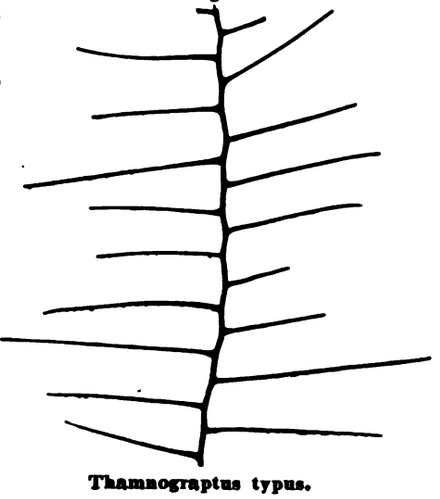
The accompanying figure is from a fragment of this species, of the natural size.

Geological position and locality. In the shales of the Hudson-river group : Near Albany.

This genus was proposed by me in 1858, in a paper read before the American Association for the Advancement of Science; but no publication has been made of

the name, so far as I know, except in a newspaper report at the time. At that time, I had seen but a few fragments of the species, the first one having been discovered by Mr. J. B. Ellis of Albany; and it is only since the descriptions were in type that the specimen, from which the accompanying figure 2 has been made, was discovered by Mr. Whitfield among the shales at Normanskill. The constancy of the generic characters in two distinct species, and in at least half a dozen specimens, affords satisfactory evidence for separating this from any described forms.

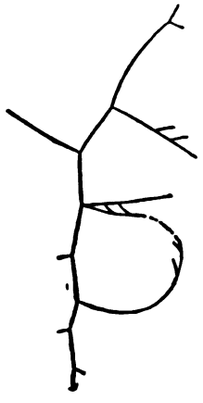
Fig. 2.



Thamnograptus typus.

Thamnograptus capillaris (n. s.).

Stipe extremely slender, flexuose or slightly divergent at the junction of the branches : branches diverging nearly at right angles to the stipe, capillary; branchlets less divergent. Surface of stipe and branches marked by numerous indentations, which may indicate the place of cellules? Substance of the stipe, branches and branchlets, nearly cylindrical.



Thamnograptus capillaris.

This species is an extremely slender form; the stipe, as preserved, being capillary, and the branches and branchlets still finer. It is not improble that what appears in the fragment as the main stipe, is a branch of a larger one; but its form and mode of branching preclude its identity with the preceding species.

The figure is from a fragment of this species, twice enlarged.

Geological position and locality. In the shales of the Hudson-river group : Near Albany.

Genus Rastrites (Barrande).

This genus was proposed by M. J. Barrande in 1850, to include certain graptolitic forms which he describes as follows :

"This polypier is composed of a small, almost linear, very long, and slightly "curved stem, provided with an interior canal forming the communication between "all the cellules. These are disposed upon the convex side of the axis, and make "with it a slightly acute angle : they are completely isolated from each other. The "proportion between their length and their reciprocal distance varies according to "the species. The diameter, in the known species, is always greater than that of "the stem to which they are fixed.

"*Distribution of species.* The Genus Rastrites has hitherto been represented "only by four forms, all belonging to Bohemia : they characterize the mass of the "Graptolite schists, constituting the base of our upper division. One of these four "forms, *Rastrites peregrinus*, is also found in Saxony.

"*Relations and differences.* It must be observed that there is a very great analogy "between the Genus Rastrites and the Subgenus Monoprion. The only characters "which lead us to separate them are : 1, The isolation and the great space between "the cells composing the polypier, which we call *Rastrites* ; 2, The great tenuity "of their filiform stems, always more slender than the alveoles which they support."

Notwithstanding some slight differences from the generic description here given, I have referred the following form to this genus :

Rastrites barrandi (n. s.).

Stipe slender, filiform, rigid, slightly curved, and furnished on the concave side with numerous, nearly regularly disposed, minute, setiform processes or cellules, at the bases of which there is a slight thickening or expansion of the principal stipe. Stipe, and cellules or processes, rounded in their natural condition.

The fragment is about two and a quarter inches in length, and in its natural state has evidently been a nearly or quite cylindrical tube, a longitudinal depressed line indicating the place of the axis. In this length there are more than forty of these minute processes; the stipe just below each one swelling out a little on that side;

the expansion terminating abruptly above, and, from its outer angle, the minute spine proceeds like the mucronate extension from the points of the serratures in some graptolites.

This form differs from the strict description of *Rastrites*, in having the stipe much larger than the cellules. Whether these points or processes are the true cellules, or extensions from them, might admit of some doubt, were observations based upon this species alone.

Rastrites barrandi.

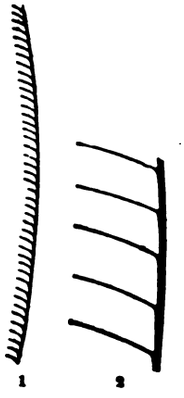


Fig. 1. View of the specimen, natural size.

Fig. 2. A part of the same enlarged.

Geological position and locality. In the shales of the Hudson-river group : Near Albany. Collected by Mr. R. P. Whitfield.

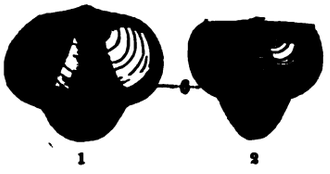
Genus Triplesia (Hall, 1858).

[Gr. τριπλασιος, *triplex*, in reference to the trilobate character of several of the species.]

Shells transverse or elongate, trilobate or subtrilobate; the ventral valve being marked by a broad deep sinuosity, and the dorsal valve by a corresponding fold. Hinge-line straight : area small; foramen triangular. External surface concentrically striated, and with fine obscure or obsolete radiating striæ : internal structure not determined.

I have proposed this name to include *Atrypa extans*, *A. cuspidata* and *A. nucleata* of Vol. i, Palæontology of New-York, as well as other species. An examination of *Atrypa extans* has shown the existence of a narrow area and small triangular foramen, as in *Spirifer;* but I have not been able, thus far, to determine the internal structure. The texture of the shell, and surface marking, although differing in some particulars from those of Merista, are nevertheless similar.

Triplesia extans.



1

2

3

Fig. 1. Ventral valve. Fig. 2. Dorsal valve. Fig. 3. Area and foramen of the ventral valve.

SUPPLEMENTARY NOTE ON THE GENUS AMBONYCHIA.

[For Observations on the Genera AMBONYCHIA and PALÆARCA, see pp. 269 – 272 of this volume.]

SINCE the preceding pages were printed, I have been able, through the kindness of Professor SAFFORD of Tennessee, to illustrate more fully the hinge-structure of *Ambonychia radiata*. The accompanying figure 1 shows the hinge-line, the cardinal teeth *t*, and the lateral teeth *tt*. On the anterior side, the margin of the shell is sinuate for the passage of the byssus *b*. The latter character is likewise more distinctly shown in figure 2, which is an anterior view of the right valve.

1

2

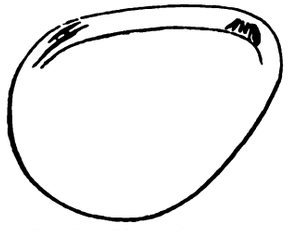
At the time that my examinations and descriptions of PALÆARCA were made (in 1857), I had overlooked the Genus CYPRICARDITES of CONRAD, which was published in the Annual Geological Report for 1841. The description and figure correspond so nearly with the fossils which I have described,

that I feel compelled to adopt the prior name, which will include those described in this volume under the Genus PALÆARCA, as well as those described by Mr. BILLINGS under the Genera CYRTODON and VANUXEMIA.

The following is the description given by Mr. CONRAD.

"GENUS CYPRICARDITES. Equivalved, profoundly inequilateral: hinge with "four or five unequal cardinal teeth, anterior one largest and most "prominent; lateral teeth short, and very remote from the cardinal "teeth."

"This genus is allied to PTERINEA of GOLDFUSS, but is never properly alated, nor "has it the very large muscular impressions of that genus: the cardinal and lateral "teeth are also different; the anterior cicatrix is often deeply impressed; the po- "sterior one not visible in casts of the interior. The genus abounds in the Silurian "rocks, but I have not seen a species from any more "recent formation*."



Cypricardites (CONRAD)†.

Mr. CONRAD describes sixteen species under this genus, among which were included the *C. bisulcata* since described by DE VERNEUIL as the type of the Genus GRAMMYSIA, under the name *G. hamiltonensis*.

---

* When these remarks were written, the Hamilton and Chemung groups were regarded by the New-York geologists as Silurian, and as being the equivalent of the Ludlow rocks of England.

† This figure is copied from the original figure of Mr. CONRAD, accompanying his description of the genus in 1841. The plate upon which this occurs was engraved to accompany the Annual Report of 1841; but unfortunately, only a small number were ever distributed, so far as known to the writer. The same plate contains illustrations of the Genera *Nuculites*, *Lyrodesma*, *Orthonota*, *Cyrtolites*, *Orthostoma*, *Dictyocrinus*, *Aspidolites* and *Dicranurus*, as well as one species of *Platyceras*; all genera proposed by Mr. CONRAD.

REMARKS

UPON THE

TRILOBITES OF THE SHALES OF THE HUDSON-RIVER GROUP,

WITH DESCRIPTIONS OF SOME NEW SPECIES OF THE GENUS *OLENUS*.

THE Trilobites most common in the shales of the Hudson-river group are *Triarthrus beckii* and *Calymene senaria* = *Calymene blumenbachii?* I have likewise described two species of OLENUS in the first volume of the Palæontology of New-York; but these are rare in most localities of the rocks of this period.

Some years since, during the progress of the Geological Survey of Vermont by Rev. Z. THOMPSON, some specimens of Trilobites were obtained from the shales of this age in the town of Georgia; and these were subsequently placed in my hands. The Survey having since passed under the direction of Professor HITCHCOCK, I postponed the publication of the descriptions, fearing it might not be agreeable to him; but having now not only his approval, but his express desire that I would publish them, I give below the following species, preliminary to a more complete description and illustration.

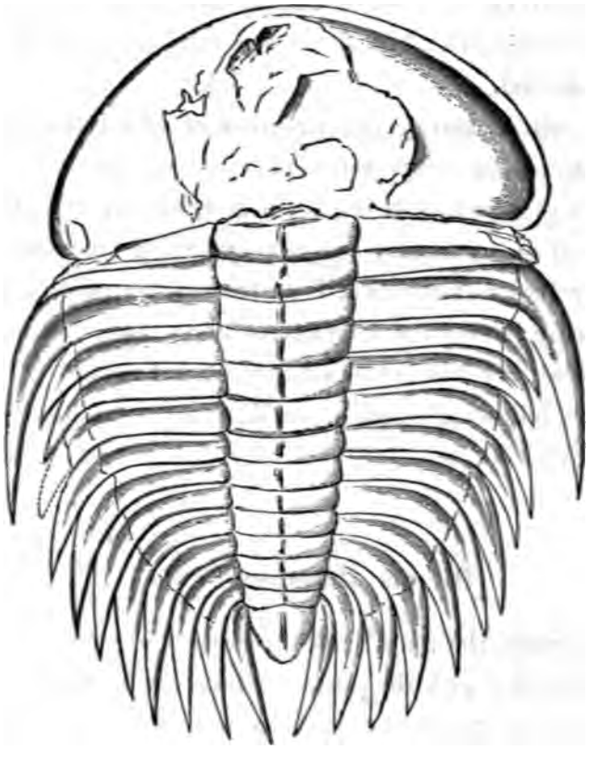
Olenus thompsoni (n. s.).

GENERAL form ovate, the length and breadth being nearly as six to five. Head broad lunate, with the postero-lateral angles much extended; the width from the centre to the outer margin of the eye almost equal to the width of the cheek. Eyes (which are much crushed in the specimen) elongate semioval, equal in length to the space between the anterior angles and the frontal margin : glabella distinctly lobed, narrower in front.

THORAX with the lateral lobes about once and a half as wide as the middle lobe, consisting of fourteen articulations, the third one of which is much longer than the others, and curving downwards with an extension reaching as far as the line of articulation of the seventh rib. The posterior articulations are bent abruptly backwards, so that the free extremities are parallel with the axis. Pygidium small, pointed, without visible rings, and having a narrow ridge running down the centre.

The description is chiefly drawn from an impression in slate, and a cast made from the same, together with some fragments of the same.

Olenus thompsoni.



Geological position. In the shales of the upper part of the Hudson-river group.

Olenus vermontana (n. s.).

General form elongate; the posterior extremity obtuse. Head semioval, twice as wide as long, the posterior angles produced in short acute spines. Eyes narrow elongate; the space from the centre of the head to the outer margin of the eye much greater than the cheek, and the distance from the anterior angle of the eye to the frontal margin less than the length of the eye. Glabella lobed : hypostoma broad oval.

Thorax imperfect, preserving six articulations and part of the seventh; the middle lobe wider than the lateral ones. The third articulation is much broader towards and at its lateral margin, and is prolonged obliquely downwards in a sharp spine, which reaches below the seventh articulation : the lateral extremities of the other articulations produced in short acute spines.

Olenus vermontana.

Another fragment, which is apparently of the same species, preserves eleven articulations of the thorax and the pygidium. The upper articulations are imperfect at their extremities; the last one is bent abruptly downwards, and terminates in a long spine on each side reaching below the pygidium. Pygidium semioval; the axis marked by four annulations, the two upper of which are faintly indicated in the lateral lobes.

This species differs from the preceding in its proportionally narrower form, the relative proportions of the parts of the head, and the short acute posterior spines. The comparative width of the middle and lateral lobes of the thorax is a very distinguishing feature.

Geological position. In the shales of the upper part of the Hudson-river group.

Peltura (Olenus) holopyga (n. s.).

Entire form elongate subelliptical, having a length of about twice and a half the width. Head somewhat semielliptical; the posterior angles produced in long spines. Glabella strongly lobed, its length a little greater than its greatest breadth; the whole breadth of the head, when entire, being about twice as great as the length. Hypostoma wider than long.

Thorax with eleven articulations; the middle lobe prominent, and about twice as wide as the lateral lobes; the articulations strong, rounded above, and each one marked in the centre by a node (or the base of a spine which has been broken off in the specimens examined). Articulations of the lateral lobes short (the extremities of the upper ones broken off in the specimen); the lower ones bending abruptly downwards and terminating in spiniform processes, the last pair being prolonged much beyond the extremity of the pygidium.

Pygidium longitudinally semielliptical; the middle lobe marked by three annulations, and a fourth obscure one above the terminal lobe: lateral lobes flat and plain, the exterior margin apparently free from ornament or inequality.

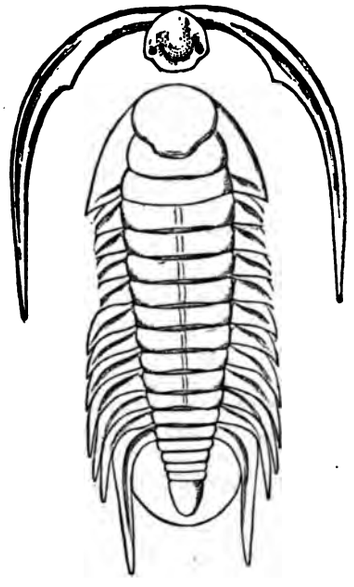
The specimen from which the description and figure have been made is imperfect, in the absence of the cheeks with the posterior spines and frontal limb. These parts, with the hypostoma attached, lie upon the stone a little in advance and turned to one side of the head of the specimen, and have been drawn in their proper relations, but not attached to the head. That this portion of a trilobite belongs to the one figured, can scarcely admit of doubt; but in the absence of an entire head, which would warrant the restoration, I have given the figure as it occurs on the stone, with merely a change of the position of the two parts. It is not proved, from this specimen, that the third articulation from the head may not have extended beyond the others, as shown in the two preceding species.

This species appears to belong to the Genus Peltura, taking the figures of *Olenus* (*Peltura*) *scarabæoides* as the type of the genus*. Our specimen differs from that one

* This species, the *Entomostracites scarabæoides* of Wahlenberg, 1821 (*scarabæorum vel aliorum vaginipennium animale vestigia*: Bromel in Act. Litt. Upsal. 1729), has apparently been drawn from

in the absence of the obscure crenulations or inequalities upon the limb of the pygidium, which is regarded by PICTET as important. The number of segments of the thorax, if a constant character, seems much more important, and furnishes a more marked feature for the separation from OLENUS.

Peltura holopyga.



Geological position. In the shales of the Hudson-river group.

NOTE. In addition to the evidence heretofore possessed regarding the position of the shales containing the Trilobites, I have the testimony of Sir W. E. LOGAN that the shales of this locality are in the upper part of the Hudson-river group, or forming a part of a series of strata which he is inclined to rank as a distinct group above the Hudson-river proper. It would be quite superfluous for me to add one word in support of the opinion of the most able stratigraphical geologist of the American continent.

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the same specimen, or from the same figure throughout, by subsequent authors; and the original appears to have been deprived of the cheeks, the frontal limb, and the posterior cephalic spines. The eye-tubercle, or the palpebral lobe, having collapsed as in our specimen, gives but a partial representation of the entire animal.

INDEX OF GENERA AND SPECIES.

PAGE

Acidaspis hamatus 371
— tuberculatus 368
ACROCULIA 308
AMBONYCHIA ..... 269 & 523
Anatina? sinuata..... 265
ANOMALOCYSTITES 132
Anomalocystites cornutus. 133
— disparilis 145
ASPIDOCRINUS 122
Aspidocrinus callosus 123
— digitatus 123
— scutelliformis .. 122
Atrypa reticularis 253
Avicula æquiradiata..... 285
— bellula 289
— communis 286
— gebhardi 466
— manticula 284
— ? naviformis..... 279
— obliquata..... 285
— obscura 280
— pauciradiata 287
— recticosta..... 466
— schoharie 283
— securiformis 290
— spinulifera 282
— subequilatera 281
— tenuilamellata ... 281
— textilis..... 288
— — *var.* arenarius, 465
— umbonata 284
BEYRICHIA 377
Beyrichia granulata..... 377
— notata 379
— — *var.* ventricosa, 380
— oculina..... 378
— trisulcata 381
BRACHIOCRINUS 118
Brachiocrinus nodosarius . 118
Bronteus barrandi 350
Bucania profunda..... 341

PAGE

CAMARIUM 486
Camarium elongatum 488
— typum 487
CAPULUS 308
CERATIOCARIS 420*
Ceratiocaris aculeatus ... 422*
— acuminatus .. 422*
— maccoyanus .. 421*
— sp.?..... 422*
Chonetes complanata 418
Conocardium inceptum.... 491
Conularia huntiana 348
— lata 479
— pyramidalis 347
— — ? 480
CORONOCRINUS 124
Coronocrinus polydactylus, 124
CYPRICARDINIA 266
Cypricardinia concentrica. 268
— crassa 268
— dorsata 267
— lamellosa..... 266
— sublamellosa... 267
CYPRICARDITES 524
Cyrtia dalmani..... 206
— rostrata 429
Cyrtoceras subrectum 342
Cyrtolites ? expansus 479
Dalmania micrurus 359
— nasutus 362
— pleuroptyx 356
— tridens..... 361
DICTYOCRINUS 135
Dictyocrinus squamifer ... 135
DISCINA 159
Discina conradi..... 161
— discus 159
— grandis..... 406
— vanuxemi 162
DOLICHOPTERUS 414*
Dolichopterus macrocheirus, 414*

PAGE

EATONIA 432
Eatonia eminens 242
— medialis 241
— peculiaris... 244, 436
— pumila..... 437
— singularis 243
— sinuata..... 438
— whitfieldi..... 437
EDRIOCRINUS 119
Edriocrinus pocilliformis.. 121
— sacculus. 143
Euomphalus disjunctus ... 340
— sinuatus 340
EURYPTERUS 382, 395
Eurypterus dekayi..... 411*
— lacustris 407*
— — *var.* robustus, 410*
— microphthalmus, 407*
— pachycheirus ... 412*
— pustulosus..... 413*
— remipes 404*
GLADIOLITES 517
GRAPTOLITHUS..... 495 – 501
Graptolithus (germs and young) 507 & 508
Graptolithus abnormis ... 503
— angustifolius... 515
— divaricatus 513
— divergens..... 509
— gracilis..... 510
— logani 502
— marcidus..... 514
— multifasciatus . 508
— spinulosus..... 517
— whitfieldi..... 516
Holopea antiqua 294
— *var.* pervetusta, 295
— danai 295
— elongata 295
— subconica 294
Homalonotus vanuxemi .. 352

	Page
HOMOCRINUS	102
Homocrinus proboscidalis	138
— scoparius	102
LEPADOCRINUS	125
Lepadocrinus gebhardi	127
Leperditia alta	373
— hudsonica	375
— jonesi	372
— parasitica	376
— parvula	376
Leptæna concava	197
— ? nucleata	419
LEPTOCŒLIA	447
Leptocœlia concava	245
— dichotoma	452
— fimbriata	450
— flabellites	449
— imbricata	246
Lichas bigsbyi	364
— pustulosus	366
Linugula centrilineata	155
— perlata	156
— rectilatera	156
— spathata	157
— spatiosa	158
Loxonema attenuata	296
— compacta	297
— fitchi	296
— ? obtusa	297
— planogyrata	298
MARIACRINUS	104
Mariacrinus macropetalus	111
— nobilissimus	105
— pachydactylus	107
— paucidactylus	109
— plumosus	110
— ramosus	147
— stoloniferus	112
MEGAMBONIA	273
Megambonia aviculoides	274
— bellistriata	467
— cordiformis	278
— lamellosa	467
— lata	277
— mytiloidea	276
— oblonga	277
— obscura	277
— ovata	279
— ovoidea	276
— rhomboidea	275
— spinneri	274
— suborbicularis	273
Merista arcuata	249

	Page
Merista bella	248
— bisulcata	253
— (indet.)	252
— lævis	247
— lata	431
— meeki	252
— princeps	251
— subquadrata	249
Modiolopsis? dubius	264
Murchisonia bilirata	299
— extenuata	298
— minuta	298
NUCLEOSPIRA	219
Nucleospira concentrica	223
— elegans	222
— ventricosa	220
OLENUS	525
Olenus thompsoni	525
— vermontana	527
Oncoceras ovoides	342
Orthis assimilis	175
— concinna	172
— cumberlandia	481
— deformis	174
— discus	165
— eminens	167
— hipparionyx	407
— insignis	173
— multistriata	176
— musculosa	409
— peduncularis	174
— perelegans	171
— planoconvexa	168
— oblata	162
— — *var.* emarginata	164
— strophomenoides	177, 481
— subcarinata	169
— tubulostriata	166
— varica	179
Orthoceras arenosum	480
— clavatum	345
— ——?	345
— helderbergiæ	345
— longicameratum	343
— pauciseptum	346
— perstriatum	346
— rigidum	344
— rudis	346
— subtextile	344
— tenuiannulatum	345
PALÆARCA	271, 523
Palæarca saffordi	271
— ventricosa	271

	Page
Peltura holopyga	528
Pentamerus galeatus	257
— littoni	262
— pseudogaleatus	259
— verneuili	260
Phacops hudsonicus	355
— logani	353
PHOLIDOPS	480
Pholidops ovatus	495
— squamiformis	490
— terminalis	490
PHYLLOGRAPTUS	504
PILEOPSIS	308
PLATYCERAS	309
Platyceras agreste	338
— arcuatum	336
— billingsi	315
— bisinuatum	318
— bisulcatum	327
— calantica	328
— clavatum	337
— curvirostrum	338
— dilatatum	322
— elongatum	335
— — ? *var.*	335
— gebhardi	312, 474
— gibbosum	323
— incile	332
— intermedium	321
— lamellosum	330
— magnificum	476
— multisinuatum	319
— newberryi	333
— nodosum	473
— obesum	329
— patulum	477
— pentalobus	319
— perlatum	328
— perplicatum	325
— pileiforme	327
— platyostomum	326
— — *var.* alveatum	326
— plicatile	325
— plicatum	334
— pyramidatum	336
— reflexum	477
— retrorsum	320
— — *var.* abnormis	321
— robustum	313
— sinuatum	314
— spirale	331
— subnodosum	474
— sulcoplicatum	324

	Page
Platyceras tenuiliratum	317
— tortuosum	472
— ?	473
— tubæforme	332
— trilobatum	316
— undulostriatum	336
— unguiforme	322
— unisulcatum	316
— ventricosum,	311, 475
— (Platyostoma) callosum	478
Platycrinus parvus	114
— plumosus	113
— ramulosus	115
— tentaculatus	116
PLATYOSTOMA	299
Platyostoma arenosa	302
— depressa	301
— subangulata	301
— ventricosa,	300, 469
Pleurotomaria labrosa	339
Proetus protuberans	351
PROTASTER	134
Protaster forbesi	134
PTERYGOTUS	416*, 424*
Pterygotus cobbi	417*
— macrophthalmus,	418*
— osborni	419*
RASTRITES	521
Rastrites barrandi	521
RENSSELÆRIA	454
Rensselæria æquiradiata	255
— cumberlandiæ	464
— elliptica	256
— intermedia	463
— lævis	256
— marylandica	461
— mutabilis	254
— ovalis	458
— ovoides	456
— suessana	459
RETEOGRAPTUS	518
Reteograptus geinitzianus	518
RETIOLITES	517
Rhynchonella abrupta	228
— acutiplicata	232
— æquivalvis	224
— altiplicata	231
— barrandi	442
— ? bialveata	233
Rhynchonella campbellana,	239
— eminens	237
— fitchana	441
— formosa	236
— multistriata	440
— mutabilis	225
— inutilis	233
— nobilis	240
— nucleolata	227
— oblata	439
— planoconvexa	235
— pleiopleura	440
— principalis	443
— pyramidata	229
— ramsayi	446
— rudis	235
— semiplicata	224
— septata	443
— speciosa	444
— sulcoplicata	236
— transversa	234
— vellicata	230
— ventricosa	238
RHYNCHOSPIRA	213, 483, 484
Rhynchospira deweyi	216
— formosa	215, 485
— globosa	215
— rectirostra,	217, 485
SPHÆROCYSTITES	130
Sphærocystites multifasciatus,	130
Spirifer arenosus	425
— arrectus	422
— concinnus	200
— cumberlandiæ	421
— cyclopterus	199
— intermedius	424
— macropleurus	202
— modestus	203
— octocostatus	205
— perlamellosus	201
— pyxidatus	428
— saffordi	203
— submucronatus	419
— tenuistriatus	204
— tribulis	420
— vanuxemi	198
Spirorbus laxus	349
Strophodonta beckii	191
— cavumbona	187
Strophodonta geniculata	483
— headleyana	185
— intermedia	482
— leavenworthana	189
— lincklæni	415
— magnifica	414, 482
— magniventra	411
— planulata	184
— punctulifera	188
— varistriata	180
— — *var.* arata	183
— vascularia	412
Strophomena conradi	194
— radiata	193
— rugosa	195
— — *var* ventricosa,	417
— woolworthana	192
STROPHOSTYLUS	303
Strophostylus andrewsi	472
— depressus	306
— elegans	304
— expansus	470
— fitchi	306
— globosus	305
— matheri	471
— obtusus	305
— rotundatus	307
— transversus	470
TECHNOCRINUS	139
Technocrinus andrewsi	141
— sculptus	143
— spinulosus	140
— striatus	142
Tellinomya nucleiformis	263
Tentaculites elongatus	136
— irregularis	137
THAMNOGRAPTUS	519
Thamnograptus capillaris	520
— typus	519
TREMATOSPIRA	207
Trematospira camura	212
— costata	210
— multistriata	209
— perforata	208
— simplex	211
— — *var.*	211
TRIPLESIA	522
Triplesia extans	523

ERRATA.

Page 17, second line of last paragraph, *for* calcareous, *read* argillaceous.

112, 14th line from top, *for* and, *read* with.

123, 17th line from top, *for* 18, *read* 14.

129, 11th line from top, *for* wearing, *read* weathering.

137, *for* Tentaculites irregularis (n. s.), *read* Tentaculites gyracanthus (Echinus gyracanthus, EATON, Geol. Textbook, 1832, pa. 37, pl. f. 16).

138, *for* Plate lxxxiv, *read* Plate lxxxv.

139, 14th line from bottom, *for* three in series of five, *read* five in three series.

172 & 173, *for* Plate xiii, *read* Plate x a.

213, *for* Trematospira, Subgroup Rhynchospira, *read* Genus Rhynchospira. *See also* Addenda, p. 484.

215, 216 and 217, *for* Trematospira globosa, T. formosa, T. deweyi and T. rectirostra, *read* Rhynchospira globosa, R. formosa, R. deweyi and R. rectirostra. *See* Addenda, p. 484.

257 : Pentamerus galeatus, *for author and synonymy, see* Part ii, Explanation of plates; *also for* P. pseudogaleatus and P. verneuli.

259, *for* Plate xlvi, *read* Plate xlviii.

343, 11th line from bottom, *for* chamber, *reed* outer chamber.

350, 16th line from top, *for* Leperdita, *read* Leperditia.

410*, *for* Eurypterus lacustris, var. robustus, *read* Eurypterus robustus.

424, 23d line from top, *for* ventral, *read* dorsal.

427, 4th line from top, *for* dorsal, *read* ventral.

440, 13th and 14th lines from top, *for* dorsal, *read* ventral.

445, 10th line from bottom, *for* dorsal, *read* ventral.

445, 7th line from bottom, *for corrections, see* Explanation of plates.

N. B. The incorrect or incomplete references to plates (arising chiefly from printing the book in advance of the engraving), will be found corrected in Part ii, in the explanations of the plates accompanying that part of the volume.

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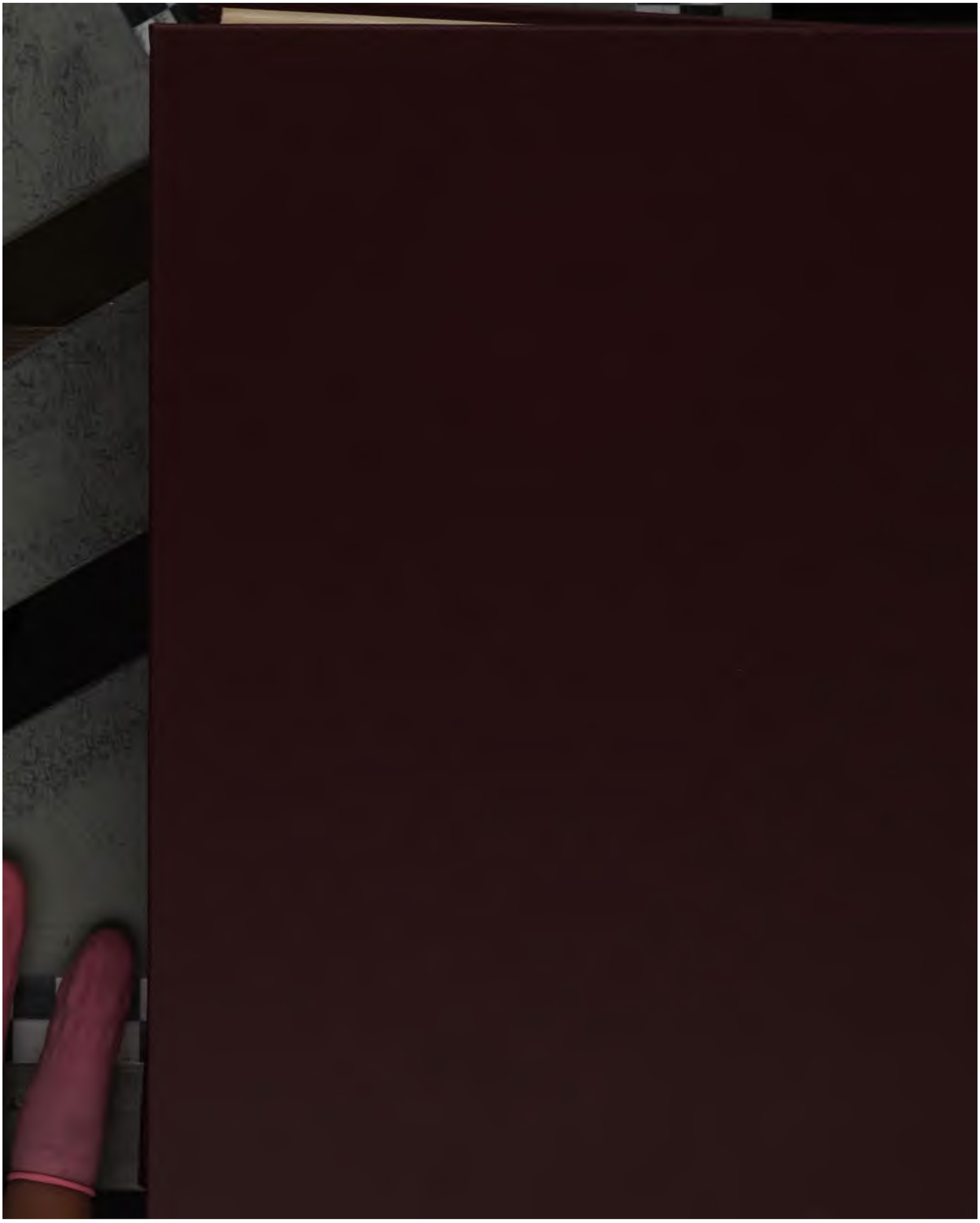
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